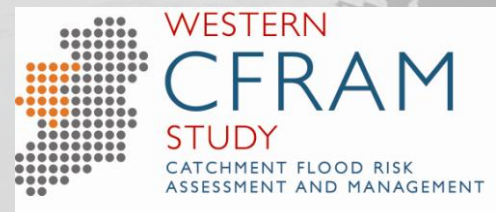


Western CFRAM Unit of Management 35 - Sligo Bay/Drowes Inception Report

Final Report

October 2012

**Office of Public Works
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Executive Summary

Western CFRAM

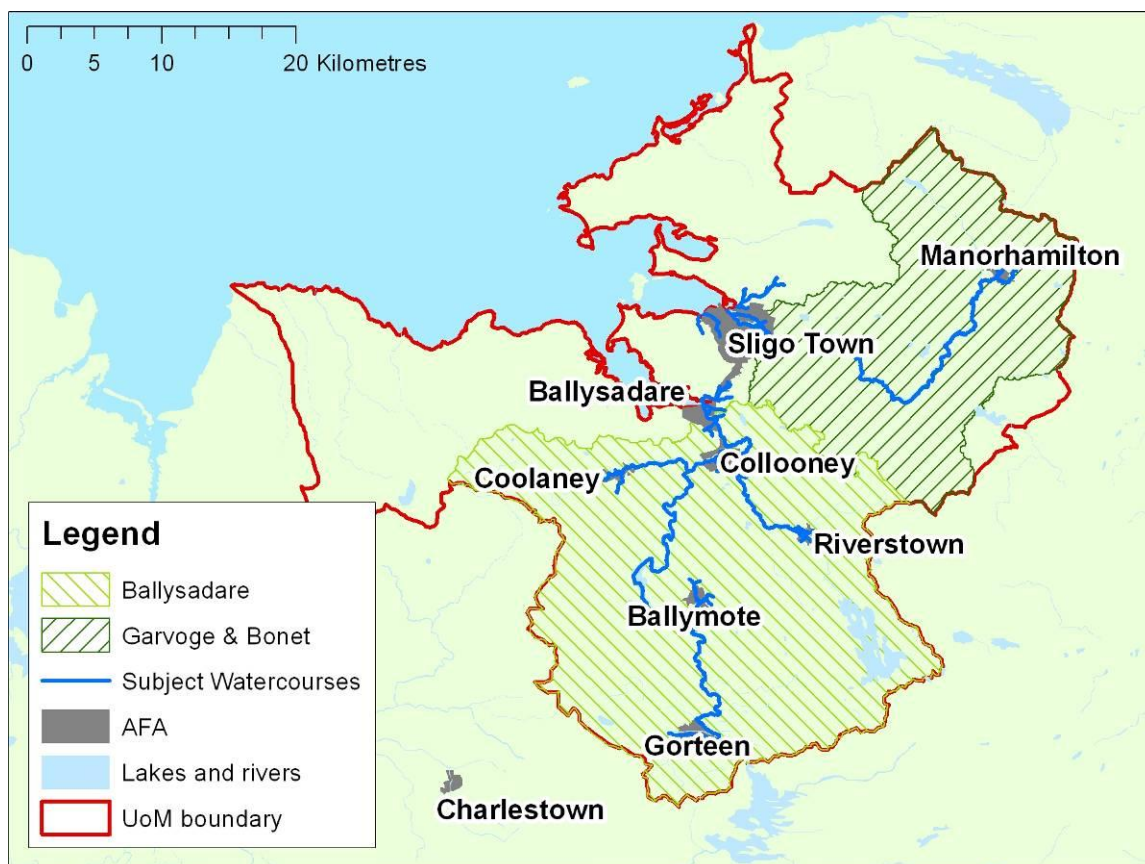
The Office of Public Works (OPW) has recognised that, in some areas of the country, there are significant levels of flood risk which could increase in the future due to climate change, ongoing development and other pressures. In partnership with Local Authorities, the OPW are therefore undertaking a programme of Catchment-based Flood Risk Assessment and Management (CFRAM) Studies to find solutions to manage this flood risk in a sustainable and cost effective way. The CFRAM studies will be carried out between 2011 and 2015. The outputs from the CFRAM Studies will be catchment-based Flood Risk Management Plans (FRMP) and associated flood maps. The FRMPs will be valid for the period 2015- 2021 and will be reviewed on a six-yearly basis. The results will help long-term planning for reducing and managing flood risk across Ireland.

The Western River Basin District (RBD) covers an area of 12,193 km² in the west of Ireland extending north from the town of Gort to close to the border with Northern Ireland. It covers the majority of counties of Galway, Mayo and Sligo, along with some of County Leitrim and small parts of the counties of Roscommon and Clare. The Western RBD is subdivided into seven Units of Management (UoMs), which are based on hydrometric areas. It should be noted that the Western CFRAM Study is concerned with river and coastal flooding; groundwater flooding, which is a significant issue in some parts of the RBD, will be examined in a separate study.

This Inception report is for Unit of Management 35, also referred to as Sligo Bay/Drowes, which covers an area of 1,603 square kilometres of the Western RBD. The area is predominantly within County Sligo but also incorporates an area in the north of County Leitrim.

The Areas for Further Assessment (AFAs) in UoM 35 are Ballymote, Ballysadare, Collooney, Coolaney, Gorteen, Manorhamilton, Rathbraghan - Sligo Town, Riverstown and Sligo Town.

Unit of Management 35 including AFAs and the main associated river catchments



This purpose of the inception reports is to provide:

- The interpretation of all data identified, collected and reviewed, including data requirements and potential impacts of missing data.
- A preliminary hydrological assessment, including a review of historical floods and hydrometric and meteorological data
- A detailed methodology, including key constraints, data issues or other critical items that might give rise to opportunities for, or risks to, the Project.

Data collection

The Western CFRAM requires the collection and analysis of a large amount of data. All incoming data is recorded in a data register and assigned a Data Quality Score. Some key data notes include:

- There are no sub-daily raingauges within the study area. The closest is at Knock Airport, 21km south-west of Gorteen and 46km from Sligo.
- In total there are 11 river level gauges that have been judged as potentially useful for this study, i.e. either on rivers that are to be modelled or nearby gauges with good quality flood peak datasets that represent potential pivotal sites. At 8 of these gauges it is possible to calculate flow from the observed water levels using a rating equation for at least part of the record. Six of the stations (two of which do not currently have ratings) have been identified for review and extension of rating equations within this study.
- There is a tide level gauge at Sligo which will be useful for calibrating the coastal models for the same AFA and will be the main data source for the Ballysadare AFA.
- There have been a number of previous studies within the UoM which are being utilised in this study.

Design flow estimation

There is a variety of types of catchment for which design flows are needed.

On the lower parts of the catchments, at Sligo, Ballysadare and Collooney, floods are prolonged and some are difficult to regard as single events because they occur as a result of sequences of rain storms. Although the primary impact of a flood may be due to the peak water level that is reached, secondary damage is largely the result of the duration of flooding. A consequence is that accurate estimates of flood durations and volumes may be important on these catchments.

In contrast, the catchments at Manorhamilton and Coolaney are short and steep with little storage available and thus floods are much briefer and can be characterised more fully by their peak flow and level.

The catchments at Gorteen and Ballymote are small and ungauged. Riverstown has a medium-sized catchment, with two watercourses joining. The larger one, the Unshin River, is likely to be substantially influenced by Lough Arrow.

These varied characteristics call for a variety of flood estimation techniques. Where there are flow gauges at or near to AFAs, the natural choice of method will be to estimate both design peak flows and design hydrographs from locally recorded data where its quality and length of record are adequate. Peak flows will be estimated from QMED derived from at-site gauged data or by data transfer using upstream or downstream gauges as pivotal sites where possible. Flood growth curves will be derived from a combination of single-site and pooled analysis, with comparisons made between the two at all gauges with at least 10 years of good-quality annual maximum flow data.

For ungauged watercourses, QMED will be estimated from catchment descriptors. Although this initial estimate will be adjusted wherever possible, it is unlikely that suitably representative pivotal catchments will be found for the small watercourses and so flood estimates at Gorteen and Ballymote are likely to be highly uncertain. Flood growth curves for such watercourses will be based on pooled analysis.

Several AFAs are substantially influenced by attenuation due to lakes. This is the case at Sligo, but here the effects of Lough Gill are implicitly represented in the flow data recorded at the outlet of the lake, and so it is not considered necessary to carry out flood routing calculations.

However, for estimating design flows on the Unshin at Riverstown it may be beneficial, at least for comparative purposes, to route a flood hydrograph (estimated from the FSR rainfall-runoff method) through Lough Arrow.

The table below summarises the relative confidence that can be expected in the design flows at each AFA.

Summary of expected confidence in design flows at each AFA

| AFA | Flow gauge nearby? | Quality of high flow data? | Length of record? | Remarks | Expected relative confidence in design flows |
|---------------|---|---|---|---|---|
| Sligo | Yes (New Bridge within AFA) | Moderately high and should improve | Fairly long (2001 to present) but may be compromised by drainage scheme | | Moderately high but decreasing for low AEPs due to unusual catchment (lake influence) |
| Manorhamilton | No | n/a | n/a | | Low |
| Ballysadare | Yes (Ballysadare within AFA) | Moderately high and should improve | Very long (1945 to present) | | High |
| Collooney | Some distance (Ballynacarrow 8.5km upstream of AFA) | Moderately high according to FSU | Fairly long (1970 to present) | | Moderate |
| Coolaney | Yes (Billa Bridge 4km downstream of AFA) | Moderately low but should improve | Fairly long (1972 to present) | | Moderate, perhaps high if rating extension goes well. |
| Riverstown | Some distance (Ballygrania 10km downstream of AFA) | No flows currently but rating due to be developed | Fairly long (1973 to present) | May also consider flood routing through Lough Arrow | Moderately low, perhaps moderately high if rating development goes well. |
| Ballymote | No | n/a | n/a | Small catchments | Very low |
| Gorteen | No | n/a | n/a | | Very low |

Notes:

This table concentrates on the main watercourse passing through each AFA and does not include minor tributaries. The confidence of design flows on these smaller watercourses is likely to be low.

Hydraulic modelling

Hydraulic modelling at each AFA is considered in some detail in this inception report. In order to manage expectations in the outcomes of the CFRAM, and to guide the level of detail appropriate at each stage of the assessment, we have developed a scoring system which is based on an evaluation of the likely reliability of model outputs, and the likely viability of a flood management scheme. Based on our knowledge at this early stage of the assessment, we have assigned a score for both elements to each AFA.

The scores are combined to give a model output ranking which is broken down into grades A to D and for each AFA we have completed a table which shows how the two scores have been compiled from the various contributing factors. The grades are summarised in the table below.

Model output ranking used to help categorise each AFA

| Model Output Ranking | Description |
|----------------------|---|
| A | Availability of model calibration data which will support a good modelling assessment. Good justification to promote scheme works in the short term. High scheme viability (based on flood risk impacts and scale of management options) |
| B | Some uncertainty in model output due to limitations in data is expected. Further investigation likely to be required before scheme works can be delivered in the longer term. High scheme viability (based on flood risk impacts and scale of management options), so may suggest earlier intervention. Therefore undertake a few iterations of the modelling processes, and seek more local knowledge of past events |
| C | Good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term Low scheme viability (based on flood risk impacts and scale of management options). |
| D | Low confidence in model output and unlikely to improve with more modelling. Limited evidence base to progress works Low scheme viability (based on flood risk impacts and scale of management options) with scheme in the short term. These AFAs can be completed more directly. |

A summary of the proposed hydraulic modelling for UoM35 is shown in the table below, including the model output rating and types of model required. Maps of the each AFA, annotated with comments, are available in the Figures section at the end of this report.

UoM35 hydraulic modelling summary

| AFA | Model Output Ranking | Rating Review in AFA? | Model Type | Key Considerations |
|---------------------------------|----------------------|-----------------------|---------------|---|
| Ballymote | D | No | 1D-2D Fluvial | Impact of blockage at structures. |
| Ballysadare | C | Yes | 1D-2D Fluvial | High velocities and impact of sea level rise. |
| Collooney | C | No | 1D-2D Fluvial | High velocities and impact of blockage at structures. |
| Coolaney | D | No | 1D-2D Fluvial | Impact of blockage at structures. |
| Gorteen | D | No | 1D-2D Fluvial | Informal defence structures and impact of blockage. |
| Manorhamilton | C | No | 1D-2D Fluvial | High velocities and impact of blockage at structures. |
| Riverstown | D | No | 1D-2D Fluvial | Impact of blockage at structures. |
| Sligo | C | Yes | 1D-2D Fluvial | Joint probability events may be an issue. |
| Gorteen to Collooney MPW | N/A | Yes | 1D Fluvial | |
| Coolaney to Owenmore River MPW | N/A | Yes | 1D Fluvial | |
| Riverstown to Collooney MPW | N/A | Yes | 1D Fluvial | |
| Manorhamilton to Lough Gill MPW | N/A | No | 1D Fluvial | |

In order to be able to improve some of the output rankings suggestions for additional data collection have been made. This includes additional rainfall recording (there are no gauges that can record sub-daily rainfall in UoM35) and river level recording within AFAs.

Following the inception report the hydrology and hydraulic modelling studies will proceed on the basis of the methods laid out in this document.

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Glossary

| | |
|---------------------------|--|
| AA | Appropriate Assessment |
| AEP | Annual exceedence probability |
| AFA | Area for further assessment |
| AMAX | Annual Maximum |
| APSR | Area of Potential Significant Risk |
| BFI _{soil} | Baseflow index from soil type |
| CAR | Community at risk |
| CFRAM | Catchment flood risk assessment and management |
| DAD | Defence asset database |
| DAS | Defence asset survey |
| DoECLG | Department of Environment, Community and Local Government |
| DoEHLG | Department of Environment, Heritage and Local Government |
| DEM | Digital elevation model (Includes surfaces of structures, vegetation, etc) |
| DQS | Data quality score |
| DTM | Digital Terrain model ('bare earth' model; does not include surfaces of structures, vegetation, etc |
| EC | European Community |
| EPA | Environmental Protection Agency |
| ESB | Electricity Supply Board |
| ESRI Arc Map | GIS Software programme |
| EU | European Union |
| EV1 | Extreme Value type 1, a statistical distribution used for flood frequency analysis (also known as the Gumbel distribution) |
| FARL | Flood attenuation from reservoirs and lakes |
| FEH | Flood Estimation Handbook (used in UK) |
| FRI | Flood risk index |
| FRMP | Flood risk management plan |
| FRR | Flood risk review |
| FSR | Flood Studies Report |
| FSU | Flood Studies Update |
| FWPM | Fresh Water Pearl Mussel |
| GIS | Geographical Information System |
| HEFS | High-end future scenario |
| HEP | Hydrological estimation point |
| HPW | High priority watercourse |
| HWA | Hydrograph Width Analysis |
| IBIDEM | Interactive Bridge Invoking the Design Event Method |
| ICPSS | Irish Coastal Protection Strategy Study |
| IPPC | Integrated Pollution Prevention Control |

| | |
|-------------------|---|
| IRR..... | Individual risk receptors |
| ISIS | One-dimensional hydraulic modelling software |
| JFLOW..... | 2-D hydraulic modelling package developed by JBA |
| LA..... | Local authority |
| LAP | Local area plan |
| LIDAR | Light Detection And Ranging |
| LN2 | 2-parameter Log Normal, a statistical distribution used for flood frequency analysis |
| MPW | Medium priority watercourse |
| MRFS..... | Mid-range future scenario |
| NACE..... | European Classification of Economic Activities. |
| Natura 2000 | The grouped sites identified under the habitats directive (SACs) and the birds directive (SPAs) |
| NHA | Natural Heritage Areas |
| NTCG..... | National technical coordination group, for CFRAM studies. |
| NPWS | National Parks and Wildlife Service |
| OPW | The Office of Public Works |
| PFRA | Preliminary Flood Risk Assessment |
| POT..... | Peaks Over Threshold |
| PR..... | Percentage Runoff |
| Q(T)..... | Flow for a given return period |
| QBAR..... | Mean Annual Flood, used in FSR methods |
| QMED | Median Annual Flood, used in FSU methods |
| RBD | River Basin District |
| RR..... | Risk Review |
| S1085..... | Main stream slope between the 10 and 85 percentiles of mainstream length |
| SAAR | Standard average annual rainfall (1961-90) |
| SAC..... | Special Area of Conservation |
| SC..... | Survey Contract |
| SEA..... | Strategic Environmental Assessment |
| SPA..... | Special Protection Area |
| SPR..... | Standard percentage runoff |
| T..... | Return period, inverse of AEP |
| Tp..... | Time to Peak |
| TUFLOW | Two-dimensional hydraulic modelling software |
| UNESCO..... | United Nations Educational, Scientific and Cultural Organisation |
| UoM | Unit of management |
| WFD..... | Water Framework Directive |
| WINFAP-FEH | Windows Frequency Analysis Package, used for FEH methods. |

1 Introduction

This chapter introduces the CFRAM programme nationally, the Western CFRAM and the specific UoM this report refers to. It also provides some background on the flood risk review already completed.

1.1 Background

The Office of Public Works (OPW) has recognised that, in some areas of the country, there are significant levels of flood risk which could increase in the future due to climate change, ongoing development and other pressures. In partnership with Local Authorities, the OPW are therefore undertaking a programme of Catchment-based Flood Risk Assessment and Management (CFRAM) Studies to find solutions to manage this flood risk in a sustainable and cost effective way.

Flood risk in Ireland has historically been addressed through the use of structural or engineered solutions to existing problems, such as through the implementation of flood relief schemes to protect towns/areas already at risk. The Irish Government adopted a new policy in 2004 that shifted the emphasis in addressing flood risk towards (OPW, 2004):

- A catchment-based context for managing risk,
- More pro-active risk management, with a view to avoiding or minimising future increases in risk,
- Increased use of non-structural and flood impact mitigation measures.

Notwithstanding this shift, engineered solutions to protect communities against existing risks are likely to continue to form a key component of the overall flood risk management strategy (OPW, 2011).

The EU Directive on the assessment and management of flood risk (the 'Floods Directive' – [2007/60/EC]) requires Member States to prepare flood maps for areas of potentially significant flood risk, and to develop Flood Risk Management Plans (FRMPs) setting out measures aimed at achieving objectives to manage the risk in these areas. In Ireland, these requirements (transposed into national law through the European Communities (Assessment and Management of Flood Risks) Regulations 2010 (S.I. No. 122 of 2010)) are being implemented through the CFRAM Studies.

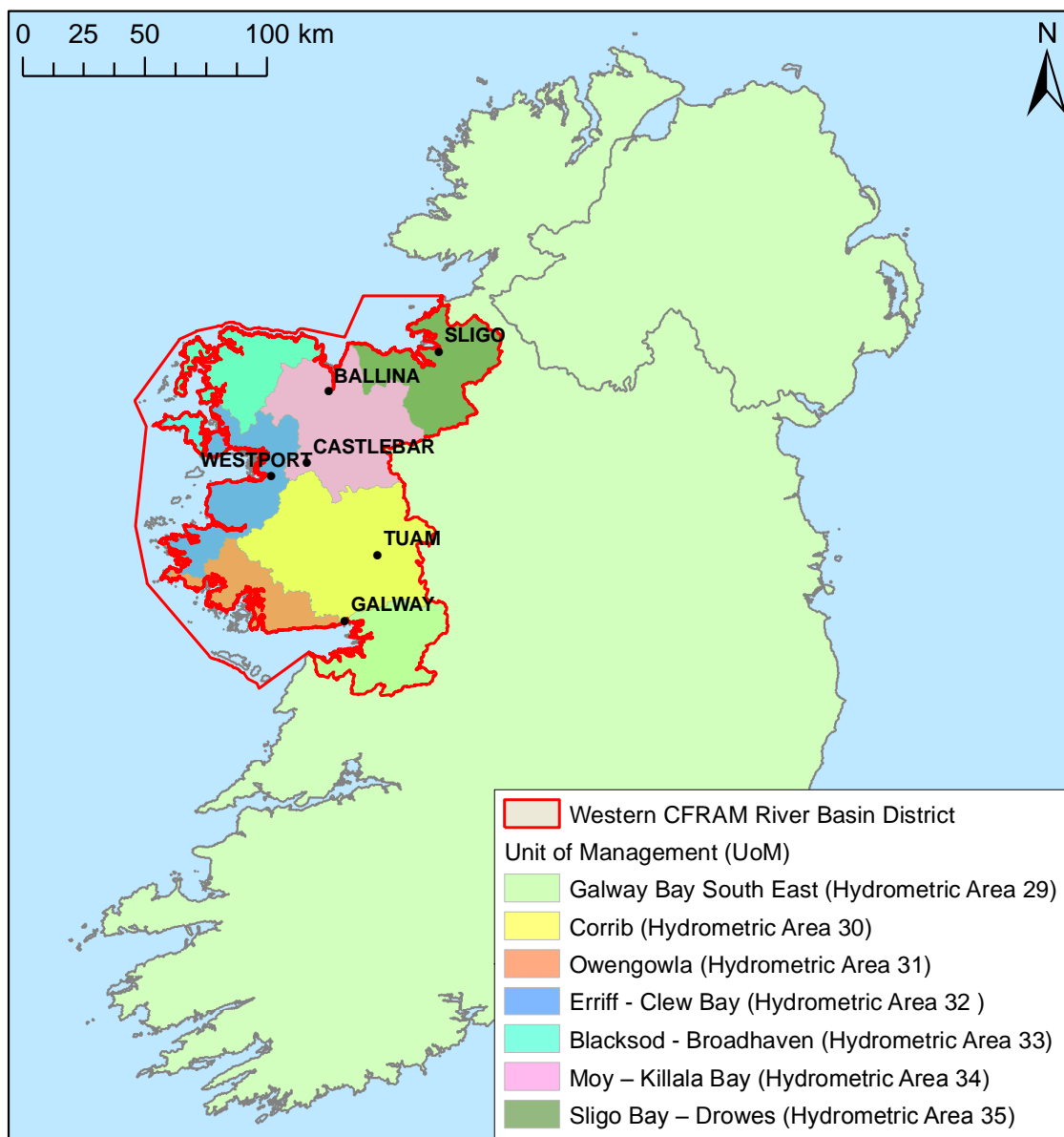
The CFRAM studies will be carried out between 2011 and 2015. The outputs from the CFRAM Studies will be catchment-based FRMPs and associated flood maps. The FRMPs will be valid for the period 2015- 2021 and will be reviewed on a six-yearly basis. The results will help long-term planning for reducing and managing flood risk across Ireland.

1.2 Western CFRAM study

The Western River Basin District (RBD) covers an area of 12,193 km² in the west of Ireland extending north from the town of Gort to close to the border with Northern Ireland. It covers the majority of counties of Galway, Mayo and Sligo, along with some of County Leitrim and small parts of the counties of Roscommon and Clare. The Western RBD is subdivided into seven Units of Management (UoMs), which are based on hydrometric areas. Figure 1-1 shows the location of the Western RBD, along with the UoMs.

It should be noted that the Western CFRAM Study is concerned with river and coastal flooding; groundwater flooding, which is a significant issue in some parts of the RBD, will be examined in a separate study.

Figure 1-1: Western CFRAM River Basin District



The objectives of Western River Basin District (RBD) CFRAM study are to:

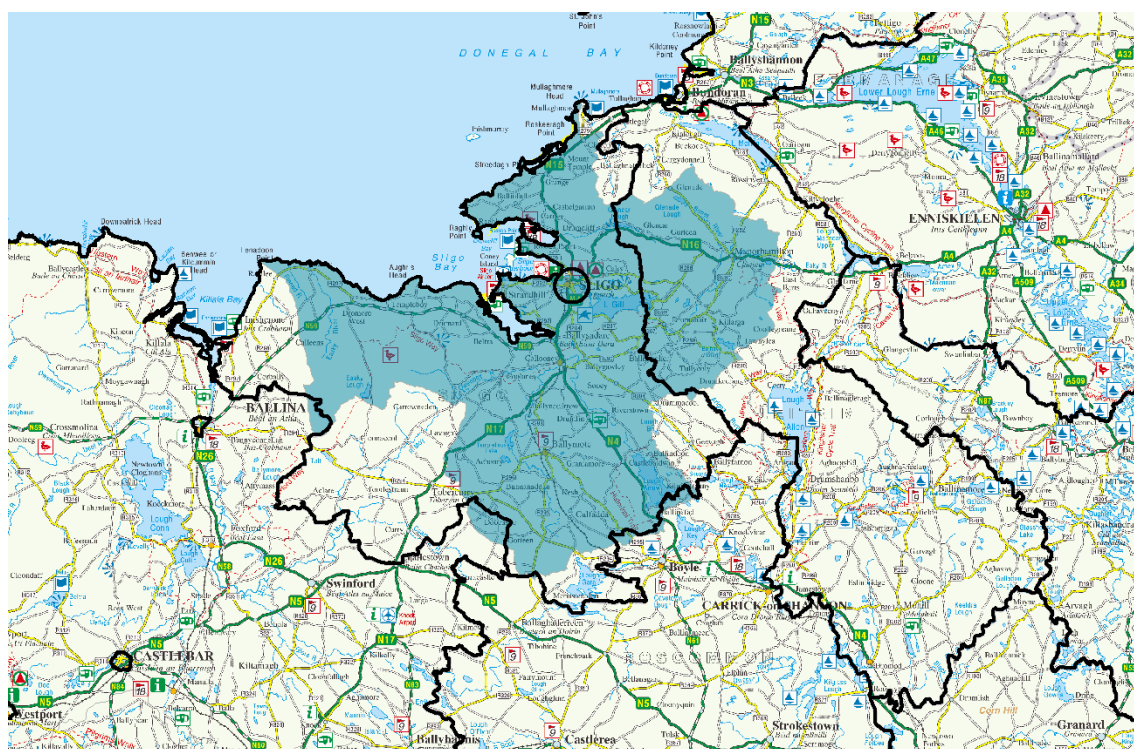
- Produce detailed flood mapping in order to identify and map the existing and potential future flood hazard and risk areas within the Western RBD.
- Build the strategic information base necessary for making informed decisions in relation to managing flood risk.
- Identify viable structural and non-structural measures and options for managing the flood risks for localised high-risk areas and within the catchment as a whole.
- Prepare a FRMP for each Unit of Management (UoM) within the Western RBD that sets out the measures and policies, including guidance on appropriate future development, that should be pursued by the local authorities, the OPW and other stakeholders to achieve the most cost effective and sustainable management of flood risk within the study area taking account of the effects of climate change and complying with the requirements of the Water Framework Directive (WFD).
- Implement the requirements of EU Directive on the assessment and management of flood risks (2007/60/EC).

1.3 Unit of Management 35 - Sligo Bay/Drowes

Unit of Management 35 outlined in Figure 1-2, also referred to as Sligo Bay/Drowes, covers an area of 1,603 square kilometres of the Western RBD. The area is predominantly within County Sligo but also incorporates an area in the north of County Leitrim. The main settlements in this UoM are:

- Sligo
- Manorhamilton
- Ballysadare
- Ballymote

Figure 1-2: Unit of Management 35: Sligo Bay/Drowes - overview map



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1.4 Inception report scope and structure

This Inception Report covers Unit of Management Area (UoM) 35 within the Western CFRAM study and its purpose is to provide:

- A detailed methodology, including key constraints, data issues or other critical items that might give rise to opportunities for, or risks to, the Project.
- The interpretation of all data identified, collected and reviewed, including data requirements and potential impacts of missing data.
- A list of flood defence assets, including identification and type.
- Specification for all channel, structure and defence asset survey (which had been prepared separately).
- A preliminary hydrological assessment, including a review of historical floods and hydrometric and meteorological data

This inception report is structured to give a clear understanding of the information used in the project, the analysis undertaken so far and the proposed next stages of the project, and covers the following areas:

1. Introduction
2. Data Collection
3. Preliminary Hydrology Assessment
4. Proposed Hydraulic Analysis
5. Risks to Programme and Quality
6. Other Stages of the CFRAM

1.5 Flood Risk Review for UoM 35

The first stage of the Western CFRAM study was to undertake a Flood Risk Review (FRR) for a number of settlements and individual risk receptors to confirm or discount the designation of Area for Further Assessment (AFA) status. The Flood Risk Review report gives full details of the assessment undertaken (available from www.westcframstudy.ie).

1.5.1 Background to Flood Risk Review

The OPW completed the draft Preliminary Flood Risk Assessment (PFRA) in July 2011 and this identified key sites within the Western River Basin District for further consideration within the Flood Risk Review. As defined in the title, the draft PFRA is a **preliminary** assessment based on the best available data. In many cases the datasets are indicative and the assessment has necessarily been broad-scale; it is important to note this when considering the selected sites.

The PFRA process identified sites as *possible* or *probable* Areas for Further Assessment (AFAs). This was done through a filtering process that broadly combined a review of historical flood risk, an assessment of predictive flood risk and a consultation phase with local authorities. The process analysed data on a 500m grid and produced a series of groups of 500m grid squares where flood risk could be significant.

Sites where this process confirmed a significant flood risk have been taken forward to the FRR as *probable* AFAs. Other, more marginal sites (*possible* AFAs), have been labelled as *Flood Risk Review* (FRR) sites or Individual Receptors at Risk (IRR) sites and are also assessed in this process. A key part of this process was the allocation of a flood risk score to each site, to allow the comparison of one site with other. This was done through the development of a *Flood Risk Index (FRI) score allocated to each site*.

The objective of the FRR was to help validate the findings of the draft PFRA, informing decisions on which sites will be taken forward as AFAs for a more detailed assessment within the CFRAM Programme. This validation was primarily undertaken through site visits and a desk based review. Visual inspections of watercourses and surrounding areas and of key assets supported an appraisal of flooding mechanisms and risks. Where available, this has been supported with anecdotal data from local residents to verify assumptions. The desk based study has analysed the available data at each site and opened discussions with local authorities to confirm historical flood risk and deliver consistency in understanding of the FRR process between key stakeholders.

1.5.2 Outcomes of Flood Risk Review

A summary of the outcomes of the FRR for UoM35 is given in Table 1-1. In some cases the JBA FRR status and Final Status differ. In these cases additional factors have been taken into account to change the FRR status following consultation with OPW and the Local Authority.

The Flood Risk Review identified nine Areas for Further Assessment (AFAs) in UoM 35. These are:

1. Ballymote
2. Ballysadare
3. Collooney
4. Coolaney
5. Gorteen
6. Manorhamilton
7. Rathbraghan - Sligo Town
8. Riverstown
9. Sligo Town

Going forward the Rathbraghan - Sligo Town AFA will be incorporated into the Sligo Town AFA as the development boundary for these sites is inextricably linked. The remainder of the CFRAM for UoM35 will focus predominantly but not exclusively on these eight areas.

All AFAs are at risk from fluvial flooding and Ballysadare and Sligo are at risk from both fluvial and tidal flooding.

Table 1-1 Summary of Flood Risk Review for UoM35

| ID | Site | County | PFRA Status | JBA FRR Status | Comment | Final Status |
|--------|------------------------|---------|-------------|--------------------|--|--------------|
| 350545 | 1SCH_Sooey | Sligo | IRR | Non-AFA | Key receptor is not at risk of flooding. | Non-AFA |
| 350547 | Ballymote | Sligo | AFA | AFA | Potential flood risk to key receptors and from debris build up provides sufficient score for inclusion. | AFA |
| 350548 | Ballysadare & Environs | Sligo | AFA | AFA (marginal) | Limited evidence of historical risk, potential hazard from high flow velocities and increased flood risk with climate change suggest inclusion as a marginal site. | AFA |
| 350549 | Collooney | Sligo | AFA | AFA (marginal) | Flood risk associated with debris build up and hazard associated with high velocities suggests inclusion as a marginal site. | AFA |
| 350550 | Coolaney | Sligo | AFA | AFA (marginal) | Flood risk in lower frequency events however the impacts of informal defences should be explored. | AFA |
| 350552 | Drumcliff & Carney | Sligo | FRR | Non-AFA (marginal) | Flood risk associated with surface water although insufficient properties at risk for inclusion. | Non-AFA |
| 350554 | Gorteen | Sligo | AFA | AFA (marginal) | Limited evidence of historical flooding although the impacts of informal defences should be explored. | AFA |
| 350555 | Grange | Sligo | AFA | Non-AFA | No evidence of historical flood risk and limited risk in extreme events. | Non-AFA |
| 350557 | Manorhamilton | Leitrim | AFA | Non-AFA (marginal) | Limited historical evidence to support inclusion but some concern regarding hazard associated with flow velocities. | AFA |

| ID | Site | County | PFRA Status | JBA FRR Status | Comment | Final Status |
|--------|------------------------|--------|-------------|----------------|---|--------------|
| 350558 | Rathbraghan Sligo Town | Sligo | AFA | Non-AFA | No evidence of historical flooding and limited risk in extreme events. Future development pressures may need assessing. | AFA |
| 350559 | Riverstown | Sligo | AFA | Non-AFA | No evidence of flood risk at the site to support inclusion. | AFA |
| 350561 | Sligo Town | Sligo | AFA | AFA | Sufficient evidence of flood risk from tidal and fluvial sources to support inclusion. | AFA |
| 350564 | Willowbrook | Sligo | FRR | Non-AFA | Limited evidence of historical flood risk at the site. | Non-AFA |

2 Data and Data Requirements

This chapter presents the data register and incoming data for the CFRAM. It includes a review of historic flood data and hydrometric data within the UoM. Key Assets and their impacts on the study area are also identified. Finally, outstanding and missing items of data are listed, along with a suggestion of the likely impact of their omission from the study.

2.1 Data collected

Data collection has been an integral part of the Inception Phase for the Western CFRAM Study. This section provides an overview of all data identified, collected and reviewed.

2.2 Data collection workflow

Data requests have been made to a number of organisations, bodies and local authorities to gather relevant datasets for use within this study. Data requests to these sources have either been made through the JBA Data Manager or by other members of the core project team who have copied the request to the data manager.

When data, including information such as that from websites and report material, have been received they are saved to the incoming data folder on the JBA network and logged within the Incoming Data sheet of the Data and Information Register.

The Data and Information Register is held as a Google Documents spreadsheet. Google Docs is a free, “cloud” based service offered by Google using a Software as a Service (SaaS) delivery model. Google Docs allows users to create and collaborate on a variety of document types including spreadsheets and text documents. Google Docs is being used to host the Data, Information and Communications Registers for the Western CFRAM Study, taking advantage of the powerful collaboration tools that the service offers. These enable a central document to be hosted that all users with an account, and access rights, can simultaneously view and edit. Access to documents is controlled by the Data Manager and is restricted to project members, the client and stakeholders.

2.3 The incoming data register

The incoming data register records metadata about datasets, information and report material that have been received during the course of the Western CFRAM Study. A copy of the Incoming Data Register (as of 29/08/2012) is presented in Appendix A. The types of information recorded are:

- Date of receipt
- Who added the record to the data register
- Who the original owner of the data/information was
- A name for the data
- How and from whom the data was received
- Details of the location of the data/information files on the JBA network
- The format the data was received in
- An assessment of the quality of the data
- Licensing information about the data
- Geographic relevance
- The size of digital files where appropriate
- Subject relevance
- General comments

Crucial elements of the metadata recorded within the data register are quality, relevance, fitness for purpose and appropriate use.

Quality assessment is recorded within two specific fields: Data Quality Score (DQS) and the Quality Comment. Relevance, fitness for purpose and appropriate use are taken into account by the subject area, comments and the licensing fields within the data register.

A Data Quality Score (DQS) has been assigned to incoming data using the established DQS system documented within the Multi-Coloured Manual¹. This is described in Table 2-1.

Table 2-1 Multi-Coloured Manual Data Quality Score (DQS)

| DQS | Description | Explanation |
|-----|------------------------------|---|
| 1 | 'Best of Breed' | No better available; unlikely to be improved on in the near future |
| 2 | Data with known deficiencies | To be replaced as soon as third parties re-issue |
| 3 | Gross assumptions | Not invented but deduced by the project team from experience or related literature/data sources |
| 4 | Heroic assumptions | No data sources available or yet found; data based on educated guesses |

The DQS system is specifically aimed at data so textual resources tend to be marked with a score of 1 unless, for example, it is known that a draft report will be replaced with an updated version. To provide a proper quality assessment of all data sources, the quality comment field is completed by the person adding the record to describe in more detail the quality of the dataset.

2.4 Historic Flood Data

Information on historic flooding will be used to develop an understanding of flood risk in the area and to guide the estimation of design flows.

Only limited information on historic flooding was available for UoM35, which includes some indication of the magnitude and/or extent of the flood. The following sources of information were used for the investigation of historic flooding.

- Irish Newspaper Archives (www.irishnewsarchive.com). The search included newspapers such as Irish Independent 1905 - 2011, Irish Press 1931 - 1995, Freemans Journal 1763 - 1924, Tuam Herald 1837 - 2000, Sunday Independent 1905 - 2011, Connacht Tribune 1909 - 2011.
- Hickey, K. (2010) Deluge. Ireland's weather disasters 2009-2010. MPG Books, Bodmin.
- A flood chronology for the Western River Basin District compiled by Kieran Hickey of Dept of Geography, NUI Galway, for the purposes of this study.
- Archer, D. (2011) Northern Ireland flood chronology. Personal communication.
- Database of historical weather events
- (<http://booty.org.uk/booty.weather/climate/wxevents.htm>)
- Local history websites and books.
- Previous flood studies for the area, as described in Section 3.2.
- Papers published in journals or presented at conferences.
- Reports and flood outlines available on www.floodmaps.ie.
- Information provided by local authorities during the flood risk review.
- Hydrometric data, in particular long-term flow and rainfall records

¹ Flood Hazard Research Centre (2010). The Benefits of Flood and Coastal Risk Management: A Manual of Assessment Techniques

Most of these sources can be regarded as good-quality datasets, although any anecdotal information, particularly if it has been gathered some time after the flood event, has been treated with appropriate caution.

2.5 Hydrometric Data

2.5.1 Meteorological Data

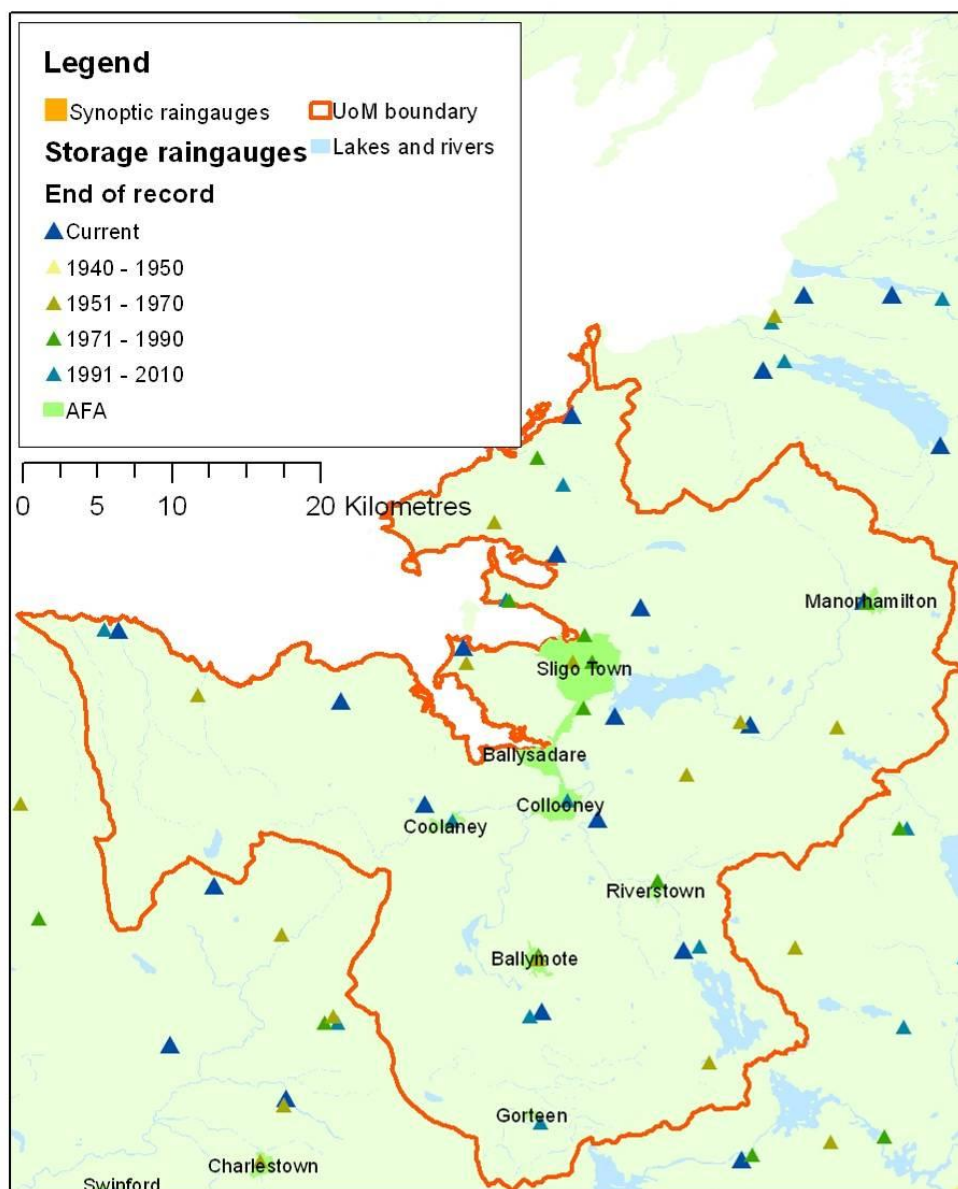
Figure 2-1 shows raingauges (past or present) for which digital data is available within this unit of management. There are no sub-daily raingauges within the study area. The closest is at Knock Airport, 21km south-west of Gorteen and 46km from Sligo.

Data from all the gauges shown has been provided by Met Éireann. The longest record is from 1941 at Markree Castle 2.5km southeast of Collooney. This gauge in fact dates back to 1860 but earlier data is available only as paper records in Met Éireann's library and has not been obtained for this study.

All Met Éireann rainfall datasets are subject to quality control procedures and thus have been treated as high-quality data. However, consistency checks have revealed a small number of suspect daily totals, which are described in the rainfall event analysis summary sheets. Apart from these exceptions, the rainfall data is regarded as fit for purpose.

Analysis of the rainfall data is reported in Sections 3.1.3 and 3.4.

Figure 2-1: Raingauge locations

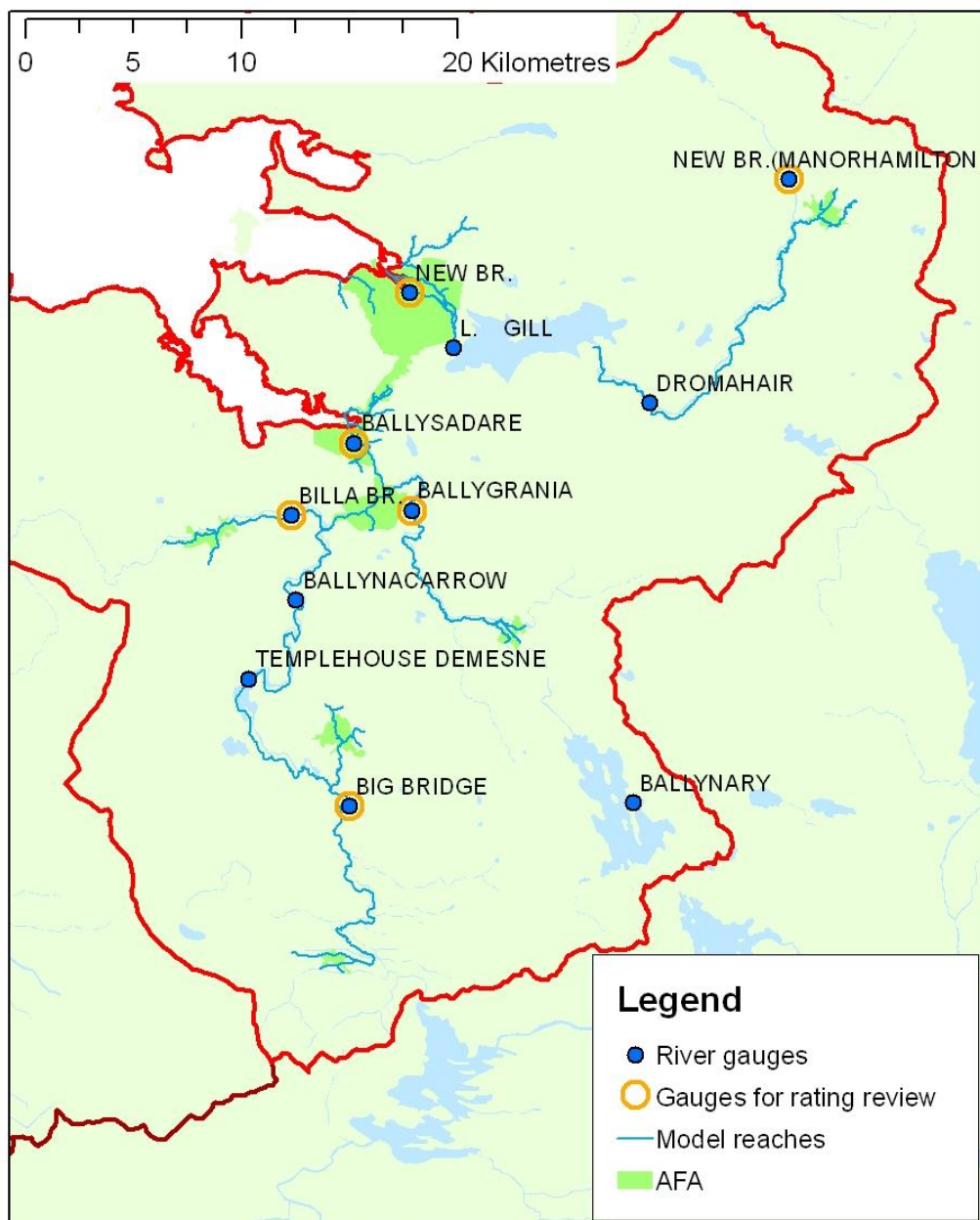


2.5.2 Fluvial Data

Figure 2-2 shows the river gauging stations in the catchments where AFAs have been identified within this unit of management. It shows only those stations at which a continuous record of river level is available, excluding staff gauges where occasional readings are taken. It includes any closed gauges as well as current ones.

In total there are 11 river level gauges that have been judged as potentially useful for this study, i.e. either on rivers that are to be modelled or nearby gauges with good quality flood peak datasets that represent potential pivotal sites. At 8 of these gauges it is possible to calculate flow from the observed water levels using a rating equation for at least part of the record. Six of the stations (two of which do not currently have ratings) have been identified for review and extension of rating equations within this study, as described in Section 3.3.

Figure 2-2: River gauge locations



Summary information on the gauges and their relevance to this study is given in Table 2-2. River level and flow data has been provided for all these gauges by the OPW and EPA.

Table 2-2 Summary of river level and flow gauges

| Number | Name | Start of record | End of record | Flow available ? | FSU quality class | Comments |
|--------|----------------|-----------------|---------------|------------------|-------------------|--|
| 35001 | BALLY-NACARROW | 1970 | - | Yes | A2 | Gauge moved in 2001 and no rating developed yet for new location. |
| 35002 | BILLA BR. | 1972 | - | Yes | A2 | Rating review gauge. Earlier data on charts from 1955 |
| 35003 | BALLY-GRANIA | 1973 | - | No | n/a | Rating review gauge (no current rating). |
| 35004 | BIG BRIDGE | 1956 | - | Only to 1970 | A1 (pre-1970) | Rating review gauge. No rating since 1970. AMAX flows to 1970; AMAX stage from |

| Number | Name | Start of record | End of record | Flow available ? | FSU quality class | Comments |
|--|--------------------------|-----------------|---------------|---------------------|-------------------|--|
| | | | | | | 1977. Gauge moved 25m downstream in 1998. |
| 35005 | BALLY-SADARE | 1945 | - | Yes | A2 | Rating review gauge. |
| 35011 | DROMAHAIR | 1957 | - | Yes | B | |
| 35012 | NEW BR. (SLIGO) | 2001 | - | Yes | n/a | Rating review gauge. |
| 35028 | NEW BR. (MANOR-HAMILTON) | 1990 | - | Yes | n/a | Rating review gauge. |
| 35073 | L. GILL | 1975 | - | Yes to 1997 or 2005 | A2 | Level-only station from 1997 although FSU AMAX flow available to 2005. Flow now available shortly downstream at 35012. |
| 35078 | TEMPLE-HOUSE DEMESNE | 2007 | - | No | n/a | |
| 35087 | BALLYNARY | 2008 | - | No | n/a | |
| Notes: 1. The start of record is given as the earlier of the year from which continuous digital data is available or the year from which flood peak data are available. Some gauges have earlier records available on paper charts. 2. FSU quality classes indicate the extent to which high flow data can be relied on as judged by the Flood Studies Update research programme. Class A gauges are thought to provide reasonable measurement of extreme floods, and thus are suitable for flood frequency analysis (the best gauges being classed as A1); class B are suitable for calculation of moderate floods around QMED and class C have potential for extrapolation up to QMED. Class U indicates gauges thought to be unsuitable at the time of the FSU research. These quality classes were developed around 2005-2006 and some may no longer be applicable following recent high flow gaugings. 4. All gauges with flow available have rating equations and check gaugings. All gauges listed have annual maximum series. 5. All gauges are operated by OPW apart from 35012 and 35073 which are operated by Sligo County Council. | | | | | | |

Analysis of the flow data is reported in Section 3.6. The flow data at most gauges is regarded as fit for purpose, apart from where stated.

2.5.3 Tidal Data

Figure 2-3 and Table 2-3 detail the location and available data associated with tidal gauges around the west coast of Ireland. Many of these gauges have been recently installed and are part of an ongoing project to develop a centrally controlled Irish national tidal network.

Due to the large distances between the gauges and the short timeframe that data is available for, the use of this data for the purposes of calibration will be limited. Where the gauge is located at the AFA, such as at Sligo, and there is a tidally influenced gauge located on the watercourse there will be good confidence in the suitability of the gauge data for the site. Where the AFAs are situated between gauges, such as Ballysadare, there will be much lower confidence in data extrapolated to the AFA. The effects of the local inlets and bays on tidal levels will not be known and calibrations using this data should be treated with caution.

Figure 2-3: Tidal gauge locations

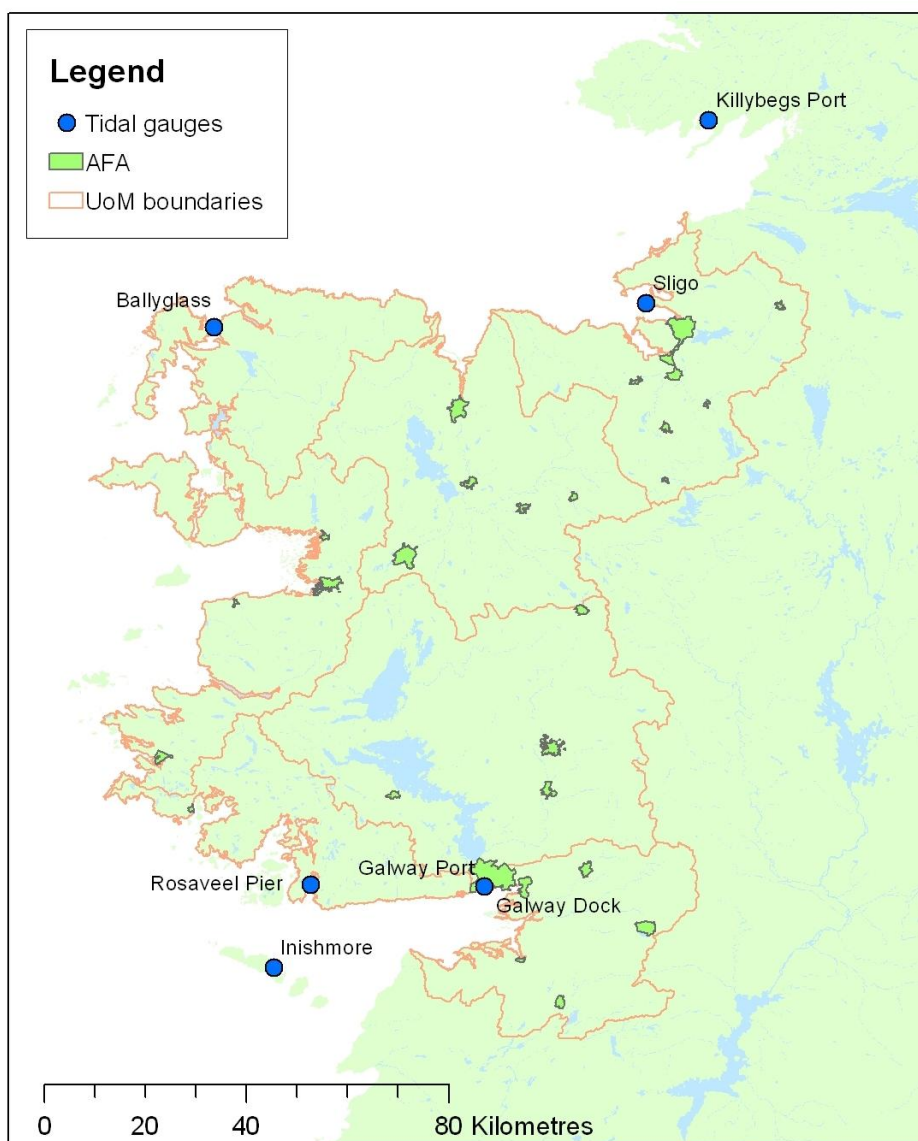


Table 2-3 Summary of tidal gauges

| Name | Operating Authority | Start of record | End of record | Comments |
|----------------------|--------------------------------------|-----------------|---------------|---|
| Killybegs | Marine Institute | Mar 2007 | - | |
| Sligo , Rosses Point | Marine Institute | Jul 2008 | - | |
| Ballyglass | Marine Institute | Apr 2008 | - | |
| Inishmore | Galway Co. Co. | Apr 2007 | - | Currently inactive due to harbour works |
| Rosaveel Pier | OPW | Jul 1986 | - | |
| Galway Port | Marine Institute/Galway Port Company | Mar 2007 | - | |
| Galway Dock | OPW | Sep 1985 | Nov 1989 | |

2.6 Flood Defence Assets

A single flood defence asset, Sligo Quay Walls, was identified within UoM 35 by the OPW prior to this study.

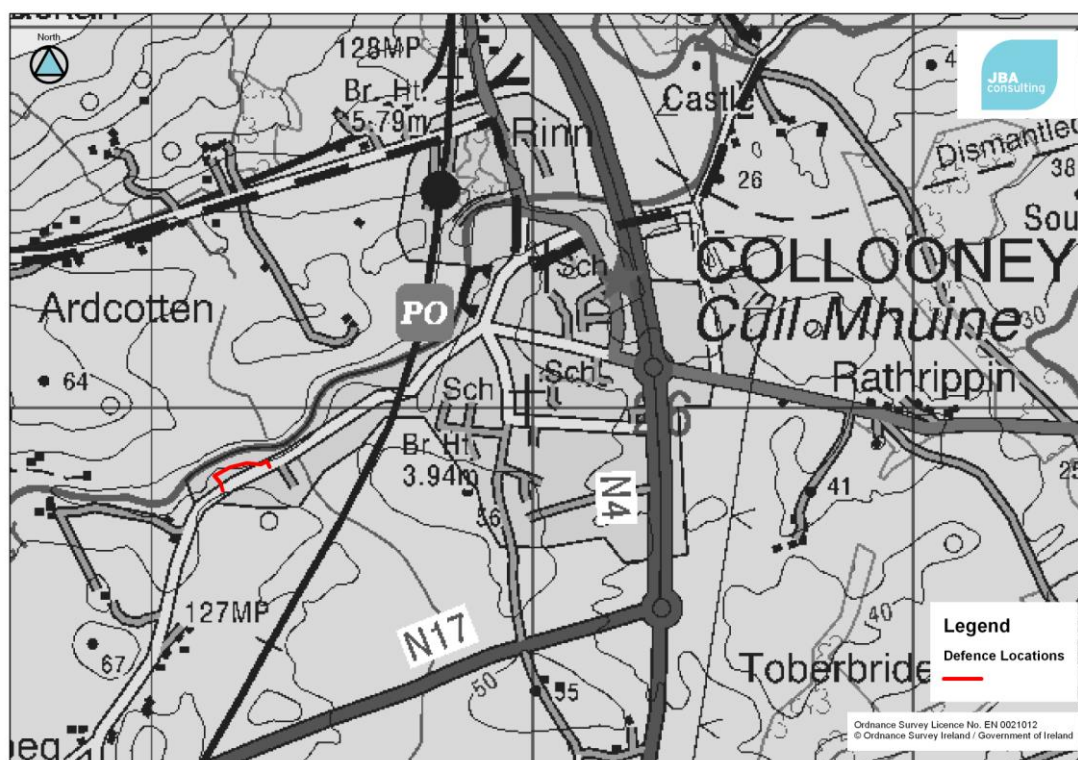
Following the FRR further structures that may provide a flood defence function but are not formal flood defences (referred to as Informal Effective Defences) have been identified in Collooney, Gorteen, Manorhamilton, Riverstown and Sligo.

The Sligo Quay Walls and those additional structures that in the view of JBA are able to provide a flood defence function are identified for condition assessment survey by JBA.

2.6.1 Collooney

A single defence was identified within Collooney, Figure 2-4. This is a raised wall located on the right bank of the Owenmore River and surrounds approximately 11 properties adjacent to Owenmore View Road. The wall appears to have been constructed along with the housing estate and circumvents the estate preventing bypassing to a degree; if flood waters reach the road the structure will provide no benefit. It is unlikely to have been designed as a flood defence and is only expected to be effective at shallow depths.

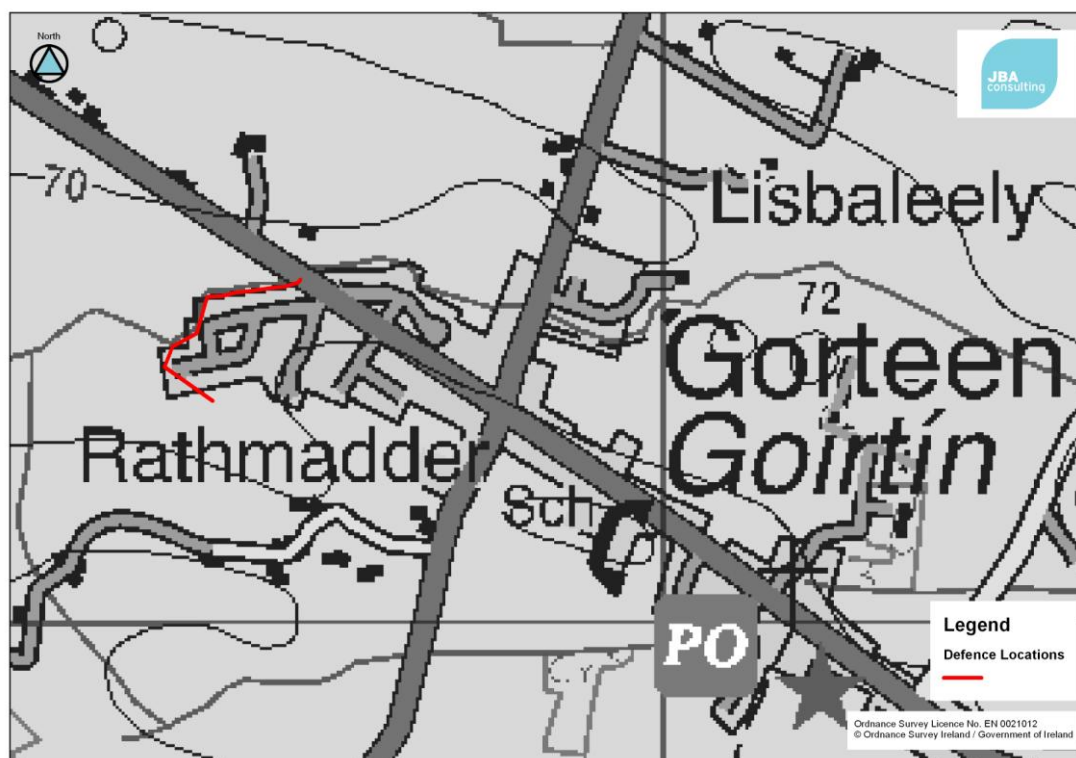
Figure 2-4: Collooney flood defence



2.6.2 Gorteen

A single defence was identified within Gorteen, Figure 2-5. This is a raised wall located on the right bank of the Gurteen River and surrounds the housing estate in this location. The wall appears to have been originally constructed as part of the housing estate development but due to its length and size it is considered that it will prevent flood waters entering the estate. There are approximately 24 properties immediately adjacent to the watercourse on Gurteen View. The defence could be bypassed at the downstream end via the road although flood waters are expected to overtop the road and return to the channel.

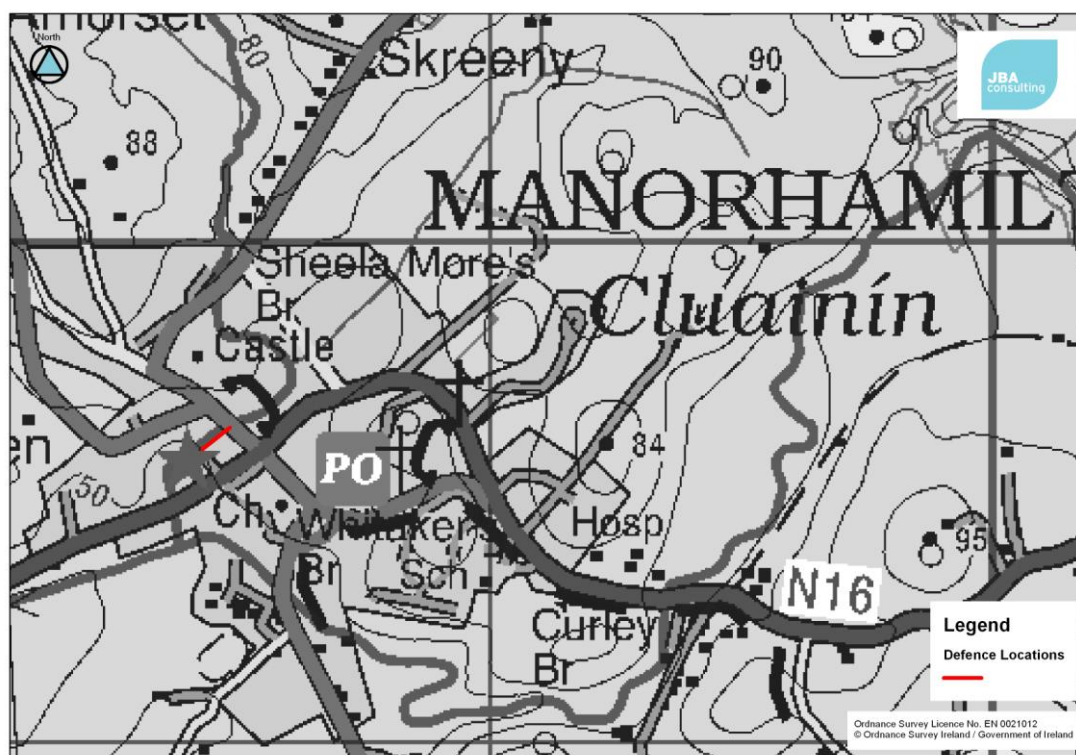
Figure 2-5: Gorteen flood defence



2.6.3 Manorhamilton

A single defence was identified within Manorhamilton, Figure 2-6. This is a raised wall located on the left bank of the Brackery watercourse. The structure is raised above the local floodplain on the right bank and it is unlikely floodwaters will reach this level. Should this not be the case the local courthouse would be affected.

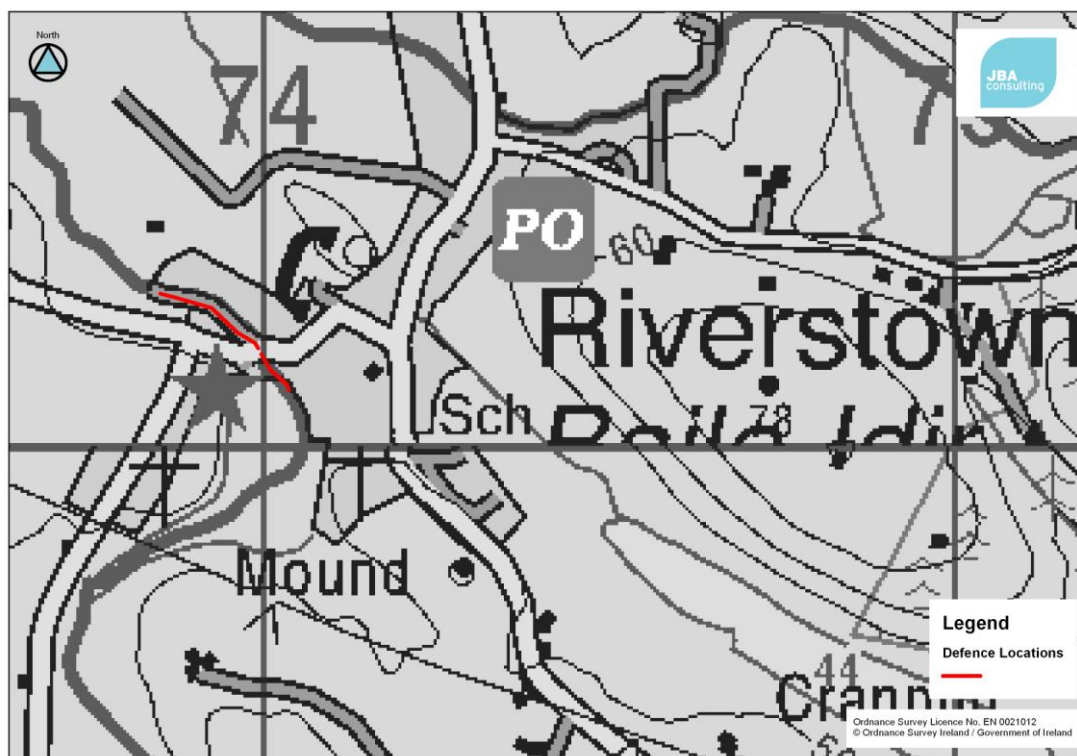
Figure 2-6: Manorhamilton flood defence



2.6.4 Riverstown

A single defence was identified within Riverstown, Figure 2-7. This is a raised wall located on the right bank of the Unshin River and extends upstream and downstream of Cooperhill Road Bridge. The structure is a low wall that could potentially be bypassed at the downstream end and there appears to be a low opening upstream of Cooperhill Road Bridge but due to its length it will provide some benefit. The main benefit of this structure appears to be reduced flooding of the road.

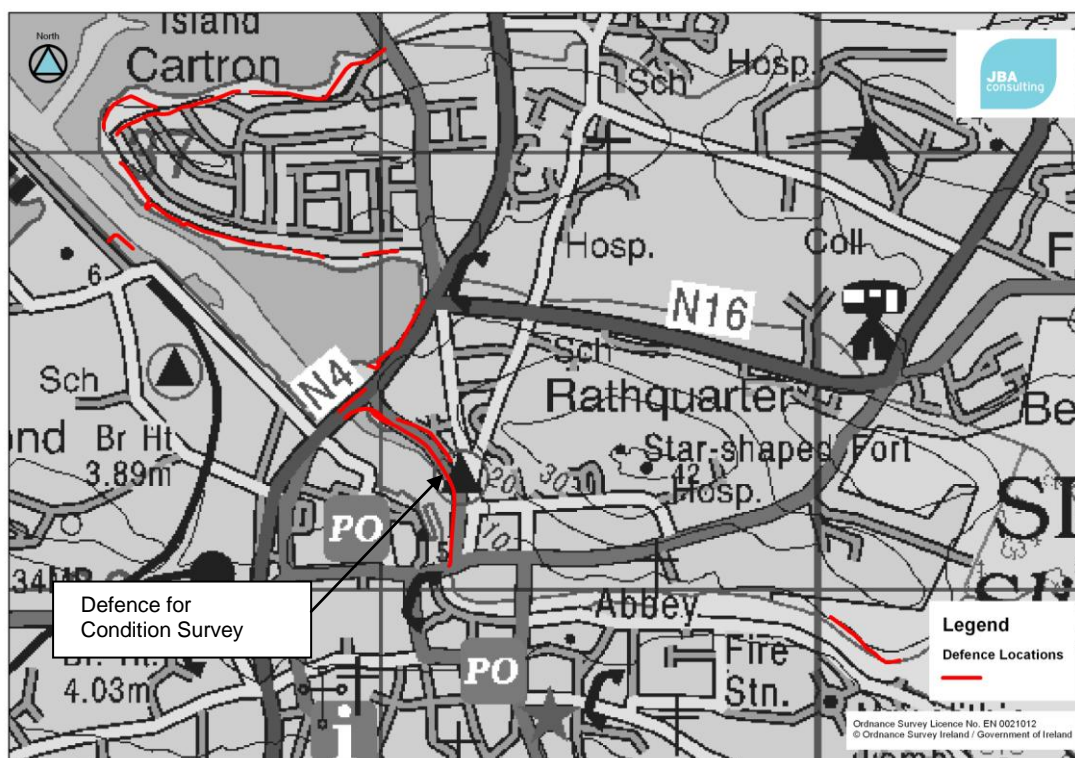
Figure 2-7: Riverstown flood defence



2.6.5 Sligo Quay Walls

Files detailing the location of the Sligo Quay Walls were provided by OPW, Figure 2-8. These sites were visited during the FRR process and in all cases bar one either no raised defence was observed or the structure was liable to be easily bypassed. A single defence from this dataset is recommended for the condition assessment survey, the raised wall on the right bank of the Garvoge River downstream of Hyde Bridge running along the R286. This potentially protects a large number of commercial properties along its length from tidal/fluvial flood risk.

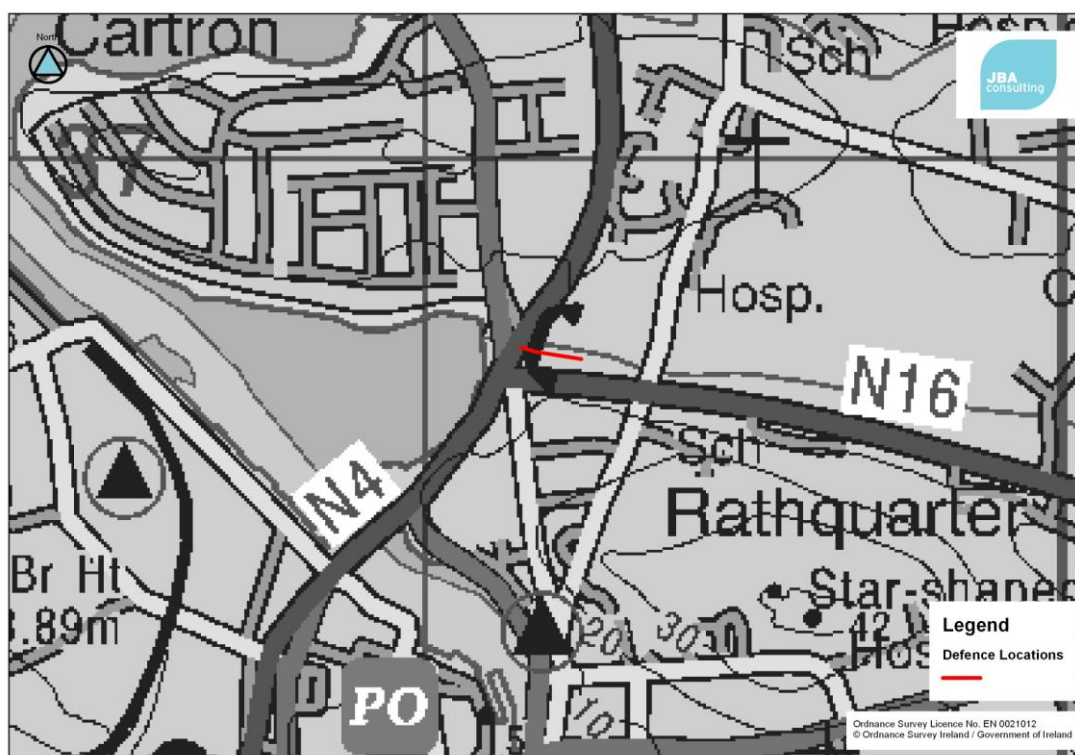
Figure 2-8: Sligo quay walls



2.6.6 Sligo

A single additional raised wall defence was identified within Sligo on the left bank of the Sligo River immediately upstream of the N4 culvert, Figure 2-9. The watercourse in this location becomes tide locked and this structure is understood to constrain tide locked fluvial flows from inundating approximately 4 commercial properties on this bank.

Figure 2-9: Sligo flood defence wall



2.7 Remaining data requirements

Details of known required data along with relevant dates and associated impacts of data not being available are presented in Table 2-4.

Table 2-4 Summary of remaining data requirements for UoM35

| Required data | Source | Date requested | Potential costs | Impacts of no data | Comments |
|--|-------------------|---------------------|-----------------|--|---|
| GIS data for WFD status of rivers | EPA | Not yet requested | None | A simplified dataset will be available in the near future | Data not available on OPW licence. |
| Data relating to, as yet, unassessed coastal water bodies in relation to WFD. | | Not yet requested | None | | |
| Higher resolution copies of the Leitrim Landscape Character Plans | | Not yet requested | None | | JBA currently have low resolution versions |
| GIS data of landscape designation as identified by different local authorities | Local authorities | Not yet requested | None | | These vary between authorities. |
| GIS data of protected structures | Local authorities | Not yet requested | None | | Should be available from local authorities. |
| Sligo, Rosses Point and Ballyglass tide gauge data for tidal model calibration | Marine Institute | Not yet requested | None - TBC? | Data should allow calibration improvement for coastal models. | Will be relevant for Sligo and Ballysadare AFAs |
| Topographic River Survey | OPW | Ongoing work by OPW | None direct | Critical to success of the project. | Delivered through National Survey Contract 6 and Western Survey Contracts 1 and 2 dependant on AFAs |
| LIDAR data | OPW | Ongoing work by OPW | None direct | Critical to success of the project. | See below for more details |
| Attributed polygon GIS files describing land surfaces, buildings etc. | OSI? | Not yet requested | None - TBC? | 2D model spatially varying roughness will not be possible to define | Usually use this type of vector mapping to describe spatially varying roughness in 2D models. |
| INFOMAR bathymetric data for Sligo bay | INFOMAR | Not yet requested | None | Unable to develop coastal model of industrial area in the outer bay. | This data is readily available from the OPW or can be downloaded |

| | | | | | |
|--|------------------------------|------------------------------------|------|--|--|
| | | | | | from the GSI website. No licensing restrictions. |
| Flow depth relationship of hydropower stations at Ballysadare and at Collooney | Irish hydropower association | 11/11/2011 and again on 10/09/2012 | None | Potential uncertainty in development of rating curve at Ballysadare which will impact catchment hydrology. | Maximum flow capacities are available on the web site. |

LIDAR aerial survey is essential for building accurate 2D models. The LIDAR data is being gathered and processed by a third party under contract to OPW, with the delivery schedule as noted in

Table 2-5. All eight AFAs have been flown (as of LIDAR progress report 29 August 2012). With no timescale available for final delivery of all sites, these are an important item of outstanding data and may be a risk to the programme.

Table 2-5: LIDAR delivery schedule (as of LIDAR progress report 29 August 2012)

| Town | AREA (km ²) | Status | Delivered to the OPW | OPW QC Complete |
|--|-------------------------|--------------------------|----------------------|-----------------|
| Riverstown | 19 | Due to JBA w/e 14th Sept | 23 July 2012 | 03 Sept 2012 |
| Gorteen | 18 | Flown | - | - |
| Ballymote | 12 | Due to JBA w/e 14th Sept | 23 July 2012 | 03 Sept 2012 |
| Manorhamilton | 16 | OPW Check Ongoing | 30th July 2012 | - |
| Ballysadare (inc Collooney and Coolaney) | 56 | OPW Check Ongoing | 7 Aug 2012 | - |
| Sligo | 37 | Due to JBA w/e 14th Sept | 23 July 2012 | 03 Sept 2012 |

Asset condition survey for three defences identified in Section 2.6 is required under the contract. These defences will be relevant to the modelling of the respective AFA.

2.8 Unavailable data

There are no sub-daily recording raingauges within UoM35 which will be a significant limit on calibration of both hydrology and hydraulic models. Radar data may be considered to help fill this gap but without data to calibrate this it may be of little benefit. Calibration of hydraulic models is discussed further in Chapter 4 of this report.

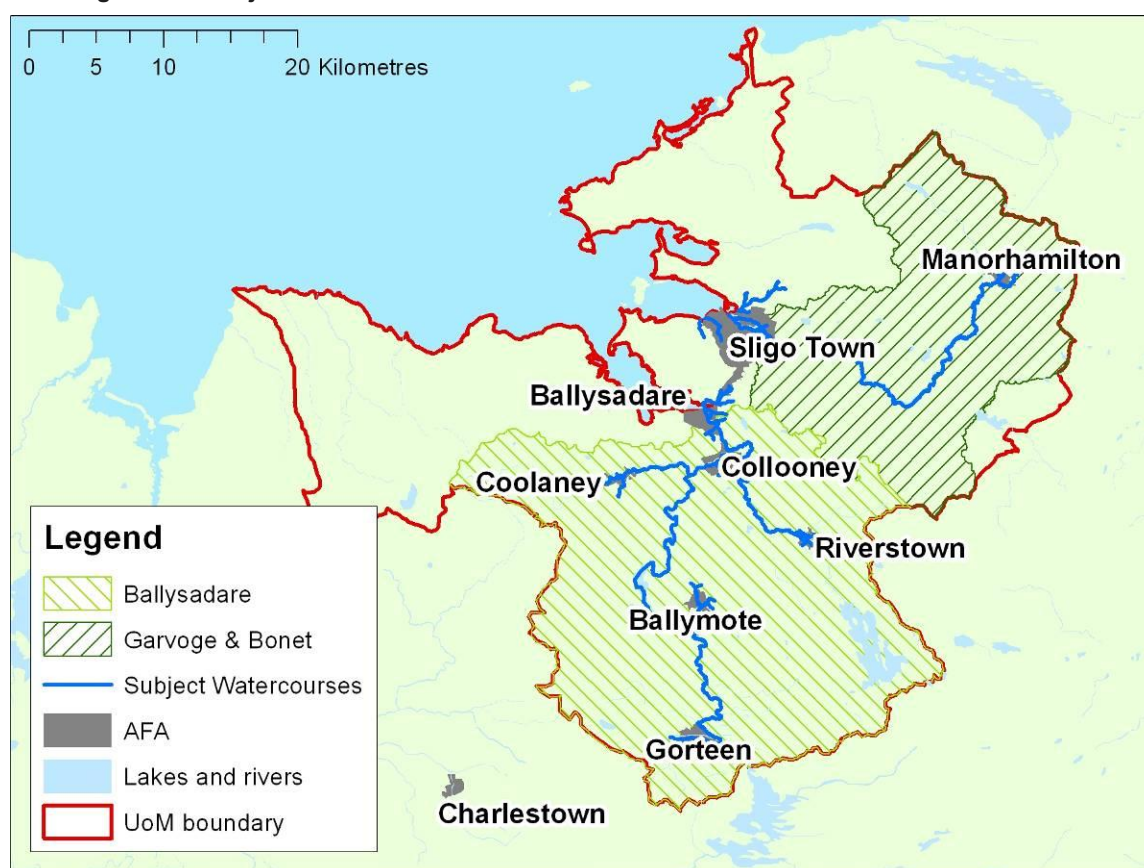
3 Preliminary Hydrology Assessment

This chapter presents the results of detailed hydrological analysis which has been carried out in order to develop an understanding of hydrological characteristics of the unit of management and how they affect flood flows on the various watercourses. The sections below include a description of the catchments, a review of previous flood studies and a summary of information that has been gleaned from analysis of data including rainfall, river flow, river level and flood history. Section 3.7 presents a method statement for the estimation of design flows. The remaining sections discuss application of flows to the river models, analysis of sea levels, simulation of future conditions and hydro-geomorphology.

3.1 Description of Catchments

The majority of the unit of management is formed of two catchments; the Ballysadare and the Garvoge (also spelt Garravogue). Upstream of Lough Gill the main channel in the Garvoge catchment is known as the River Bonet. Other smaller catchments drain into Sligo Bay. All AFAs lie within one of these two catchments. There is a discrepancy between the supplied unit of management boundary and the catchment boundaries in the east around Belhavel Lough, as discussed in Section 3.8.1. This area (around 18 km²) is evident in the figure below and shall be included within the calculations for UoM35.

Figure 3-1: Subject catchments in UoM35



The descriptions below mention catchment descriptors defined in the Flood Studies Update (FSU) Research. Details of these descriptors can be found in the relevant FSU report². Maps of selected catchment descriptors can be found in Section 3.1.3.

² Compass Informatics (2009). Flood Studies Update Programme. Preparation of Physical Catchment Descriptors (PCD). Pre-final draft report to Office of Public Works.
2011s5232 WCFRAM UoM35 Final Inception Report v3.0.doc

3.1.1 Ballysadare River

The Ballysadare River forms a significant portion of unit of management 35; its catchment is approximately 640km² which is around 40% of the unit of management. The catchment includes areas of high ground with the Ox Mountains in the west draining to the Owenbeg and the lower elevation Curlew and Bricklieve Mountains in the south. However the majority of the catchment is low-lying. The gradient of the watercourse as a whole (S1085) is 1.13m/km, which is low.

The Ballysadare River is so named only downstream of the confluence of the Owenmore and Unshin Rivers at Collooney. The larger of these tributaries is the Owenmore which rises above the town of Gorteen and (upstream of the Owenbeg confluence) has a low-lying catchment with a very gentle channel gradient of 0.44m/km, containing several small lakes. The Owenbeg joins the Owenmore shortly upstream of Collooney. Its catchment is much steeper, draining the eastern slopes of the Ox Mountains (S1085 value of 11.03m/km). The Unshin River is another low-gradient catchment (0.92m/km) apart from its headwaters. In the upper part of the Unshin catchment is a substantial water body, Lough Arrow.

The mean annual rainfall for the Ballysadare catchment is 1198mm. This varies a little across the catchment; the upland areas to the west have higher mean annual rainfall (1500mm in the Ox Mountains) and the upper areas of the catchment in the south with lower depths of around 1100mm.

The bedrock geology of the Ballysadare is predominately Carboniferous Limestone rocks with a small band of Precambrian rocks near Ballysadare. The area around the Curlew Mountains is underlain by Devonian Sandstone and Carboniferous Sandstone is present in the tributary catchment of the Unshin River. There are a number of springs and swallow holes throughout the catchment, plus several turloughs in the south. Most of the catchment is covered with well drained mineral soils, although the upland areas to the west have large accumulations of peat. The BFI_{soil} as predicted from soil characteristics is 0.61, indicating a moderate degree of soil permeability.

The catchments include a number of water bodies; the largest is Lough Arrow which drains to the Unshin River. The FARL value of the entire catchment is 0.898 indicating a moderate degree of attenuation due to lakes.

The catchment is rural but has a number of settlements including Ballysadare, Ballymote, Gorteen, Riverstown and Coolaney.

3.1.2 Garvoge and Bonet rivers

This catchment includes both the Bonet and Garvoge rivers. The Bonet flows into Lough Gill and becomes the Garvoge as it flows from this water body. Its catchment is approximately 370km² which is around 23% of the unit of management. The catchment is significantly more mountainous than that of the Ballysadare, with the Dartry Mountains in the east and several ridges of hills in the north. The majority of the catchment upstream of Lough Gill is above 100m. The gradient of the watercourse as a whole (S1085) is 2.57m/km, which is relatively low.

The Garvoge/Bonet River has a study reach approximately 35 km, beginning near the AFA of Manorhamilton. The watercourse has its headwaters in the Dartry Mountains around Manorhamilton and flows through Glenade Lough in its upper reaches.

The mean annual rainfall is 1500mm. This varies a little across the catchment; the upland areas to the east have higher mean annual rainfall (1670mm downstream of Manorhamilton).

The bedrock geology is a combination of Carboniferous Limestone, Precambrian rocks and Carboniferous Sandstone. The catchment is underlain by a wide variety of soils ranging from deep and shallow well drained minerals in the lower catchment with peats and deep poorly drained minerals in the upper catchment. The BFI as predicted from soil characteristics is 0.69, indicating relatively high soil permeability.

The catchments include a number of water bodies; the largest is Lough Gill. In the upper catchment there is also Glenade Lough and many other smaller lakes. The FARL value of the entire catchment, downstream of Lough Gill, is 0.79.

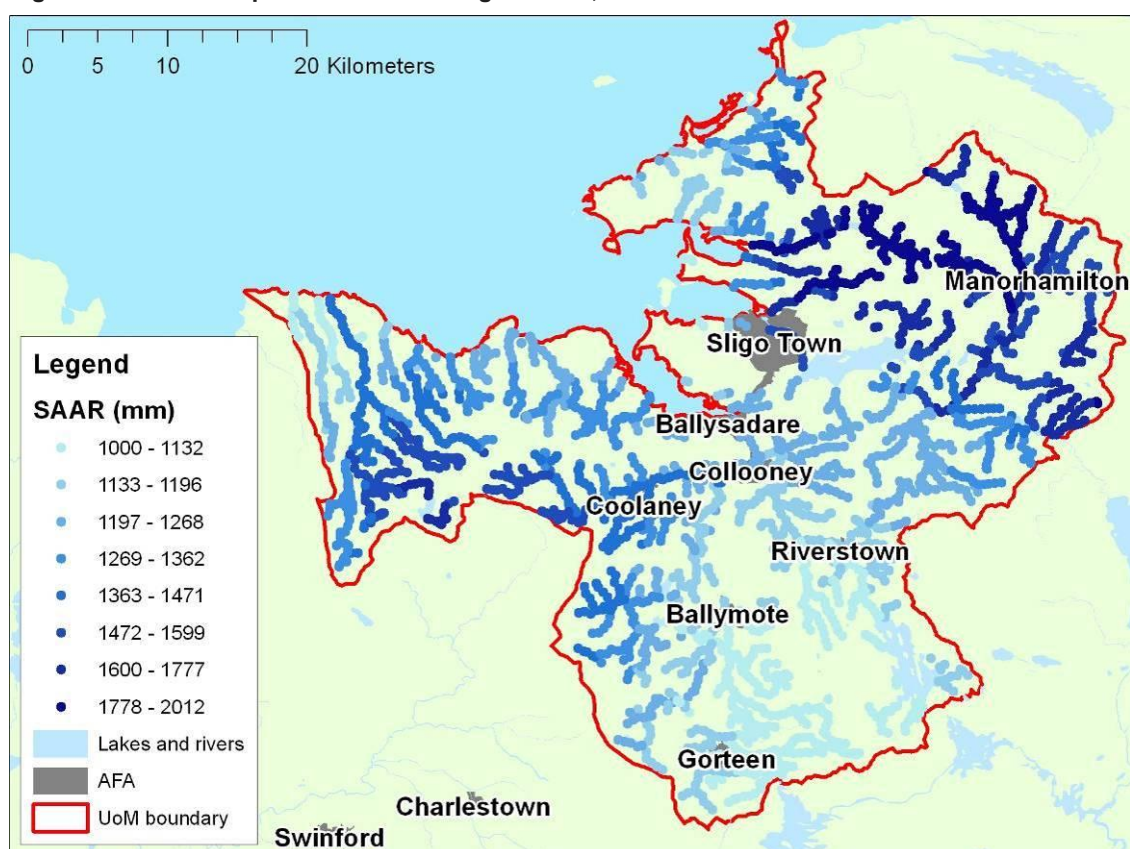
The catchment is rural with two main settlements, Manorhamilton and Sligo.

A drainage scheme was carried out on the River Bonet between 1982 and 1992. It does not appear to have been particularly successful³. It was found that the usual target standard of protection (3 year return period) could not be achieved at reasonable cost, so the target was reduced to the 1-year return period. A subsequent review found that even this was not achieved, mainly because the scheme was designed using unrealistically low channel roughness values. But flooding problems were reduced. Less than 25% of target land showed improvement as there was little installation of field drainage.

3.1.3 Maps of selected catchment descriptors

The maps below show how catchment properties vary across the unit of management. Each point indicates the properties of the catchment draining to that location. The FSU research derived values of catchment descriptors at 500m intervals along flow paths for all catchments draining an area of at least 1km².

Figure 3-2: Standard-period annual average rainfall, SAAR



³ Comptroller and Auditor General (1996). Arterial Drainage of the Boyle and Bonet Rivers. Report on Value for Money examination.

Figure 3-3: Baseflow index estimated from soil properties, BFI_{soil}

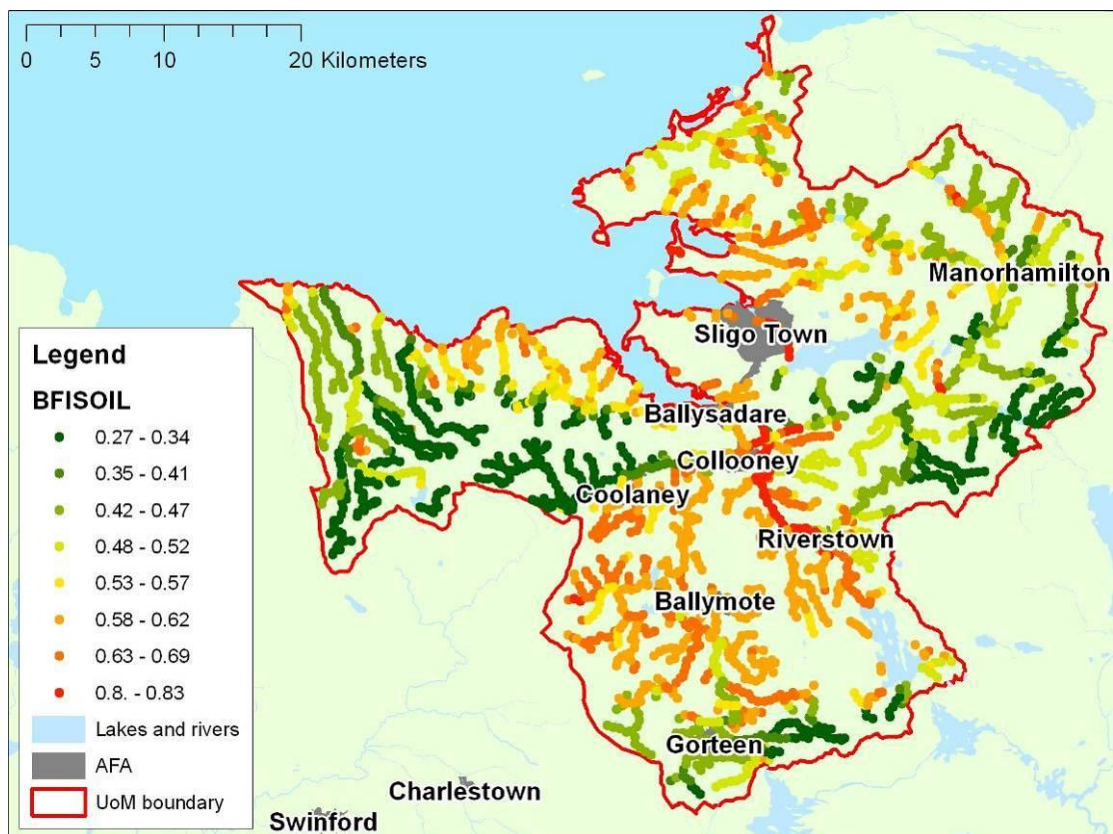


Figure 3-4: Slope of the main watercourse in the catchment, S1085

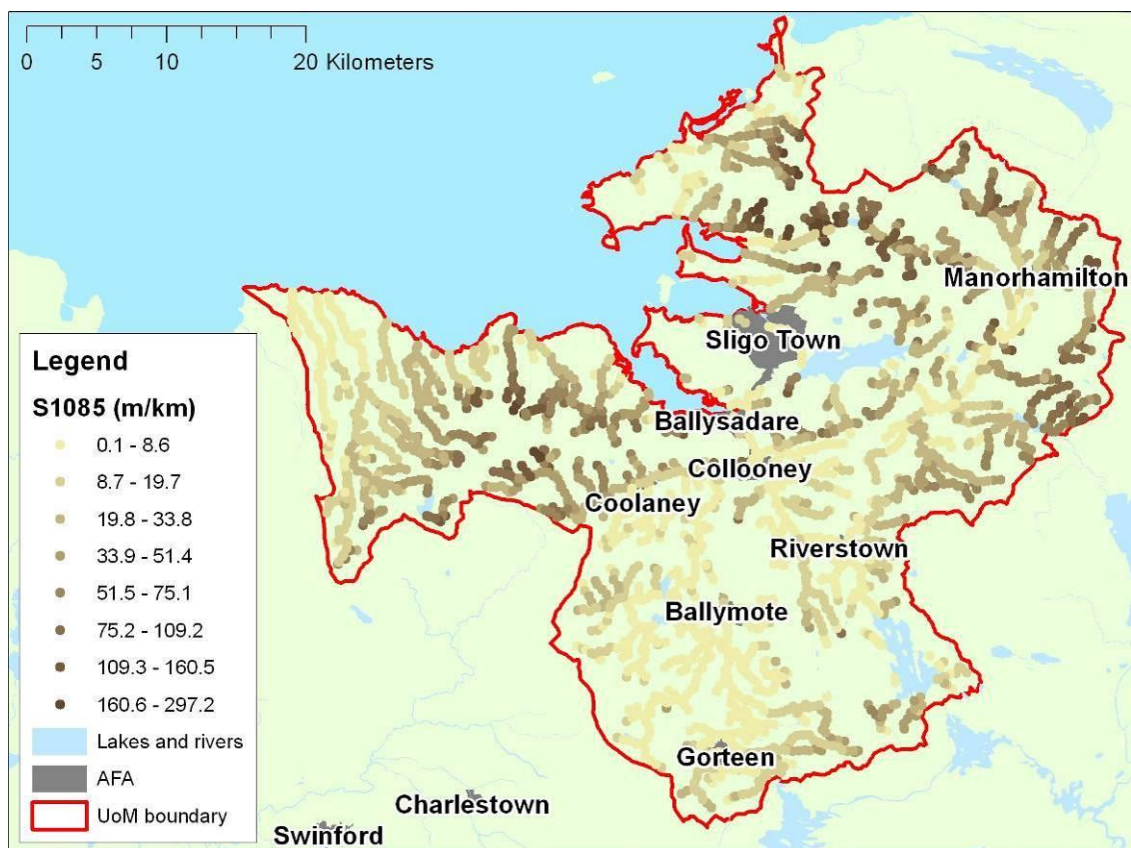
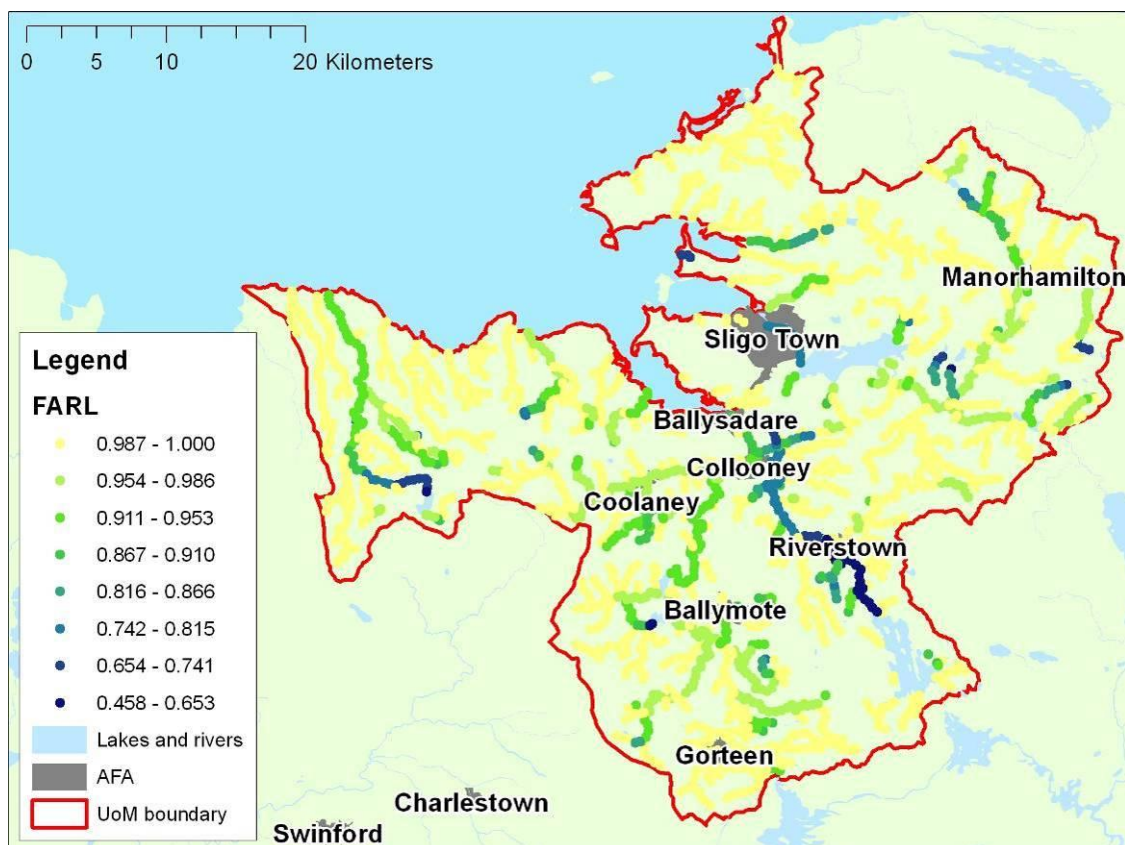


Figure 3-5: Flood attenuation by reservoirs and lakes, FARL



Downstream of Lough Gill, BFI_{soils} values are significantly higher for the Garvoge catchment than they are upstream of the lake. This is because BFI_{soils} is calculated not only from soil characteristics but also from other physical properties including the proportion of the catchment covered by standing water. The high BFI_{soils} values downstream of Lough Gill reflect the large amount of storage provided by the lough.

3.2 Reports on Previous Flood Studies

Several reports on previous flood studies have been provided for UoM 35. Those that provide information relevant to the CFRAMS are:

University College Cork (1993). **Sligo and Environs Water Supply Scheme. Hydraulic study for weir rehabilitation.** Report for Sligo County Council.

The study addressed the rehabilitation of a weir on the Garvogue River for the purposes of regulating level and flow on Lough Gill. The lake level was intended to be between 5.9 and 6.6mAOD. The report includes hydrology, flood routing and hydraulic calculations. A mathematical model of the river and lough was constructed, along with a physical model of a short reach.

Design flows were estimated from flood peak data, also from catchment characteristics and the FSR rainfall-runoff model. Annual maximum flows were said to be available at station 3575, Lough Gill from 1966. Reverse routing was applied to establish the lake inflow hydrograph for an extreme flood in September 1978.

This is rather confusing because Lough Gill is numbered station 35073 and has data only from 1975 on, when a continuous water level recorder was installed. Station 35075 is a staff gauge at Templehouse Lake which is on the Owenmore River, 19km southwest of Sligo town.

The study quotes a peak flow at Lough Gill of $85m^3/s$ in November 1968. This is before the start of the flood peak record at gauge 35073 and slightly higher than the maximum flow on record ($78m^3/s$). The source of this data is not known: it may have been a spot gauging carried out by OPW as there is a note on EPA's station file that mentions the OPW took a number of flow measurements in the 1960s. The

information is of limited value given the fact that there has been a drainage scheme on the catchment.

The 100-year design flow was estimated as $108\text{m}^3/\text{s}$.

Comptroller and Auditor General (1996). **Arterial Drainage of the Boyle and Bonet Rivers**. Report on Value for Money examination.

This is a useful report which provides more detail on the scheme than appears to be available for most other drainage schemes. The findings of the report are summarised in Section 3.1.2 above.

3.3 Initial Review of Rating Equations at Rating Review Stations

During the inception stage, existing rating equations (where available) have been reviewed and method statements developed for the extension of ratings using hydraulic models. This is a vitally important part of the hydrological analysis because the quality of design flood estimates can depend greatly on the confidence that can be placed in rating equations for measurement of flood flows. It is quite possible for extrapolated ratings to have errors of 50% or more when used to estimate the magnitude of extreme floods, so improvement of rating equations is well worth the effort.

Each gauging station has been visited in order to assess the physical characteristics of the river channel and floodplain such as hydraulic controls on water level (at low and high flows), hydraulic roughness and potential bypass routes in flood conditions. Existing rating equations, available at four of the six stations, have been assessed by comparison with check flow gaugings and confidence limits have been calculated to indicate the uncertainty associated with the rating across the range of flows.

The results of these rating reviews can be found in Appendix B. The quality of existing ratings was found to be mixed: New Bridge in Sligo was very good, with a large number of gaugings and little scatter. Billa Bridge has a good rating up to nearly QMED. Ballysadare shows some scatter. New Bridge in Manorhamilton is very uncertain at QMED. Turning to the gauges without ratings, Big Bridge lacks any recent high flow gaugings since the gauge was relocated upstream of the bridge and Ballygrania has many high flow gaugings but they show a lot of scatter. There is therefore some concern at both of these gauges at the potential for accurately calibrating the hydraulic models from which ratings can be developed.

The appendix contains recommendations on the type and extent of hydraulic modelling needed for extending the existing ratings or developing new ones. Some gauges fall within reaches which will also be modelled for the purpose of flood mapping as they are close to AFAs.

3.4 Analysis of Rainfall Data

The specification for CFRAM studies calls for analysis of rainfall data throughout each catchment in terms of severe rainfall event depths, intensities and durations and estimation of probabilities. The results of this analysis can be found in Appendix C which presents a summary sheet for each of 22 rainfall events. Analysis of rainfall has been carried out across the whole study area of the Western CFRAM. Not all events include large rainfall totals within hydrometric area 35.

The 22 rainfall events have been selected by extracting the highest rainfalls at a selection of 12 gauges across the Western RBD (2 recording raingauges and 10 daily gauges). The highest rainfall recorded within each decade was calculated for a range of durations, from 1 hour up to 8 days. From the results a number of rainfall events were selected with the aim of including events spanning a range of durations and locations.

The summary sheets in Appendix C include maps of rainfall depths (for gauges in the vicinity of catchments containing flood risk areas identified for modelling in this study), tables of rainfall depths and probabilities at selected gauges for a range of durations up to 14 days as appropriate, graphs of daily or hourly rainfall series and descriptive comments on each event.

Key daily raingauges identified for analysis in Unit of Management 35 are station numbers 636 (Markree Castle) and 1936 (Dromahair). These stations have been selected as they have long records.

At these gauges, some of the highest rainfalls on record, over a range of durations, were in late October 1968 and late October 1989.

3.5 Analysis of Flood Event Data

As required by the specification, Appendix D contains analysis of selected flood events at gauging stations in Unit of Management 35. This analysis helps in the development of an understanding of the hydrology of the catchments and in particular how the rivers respond to heavy rain.

In general the highest two or three flood events on record for which continuous flow data is available have been analysed. Each summary sheet includes a plot of the flow and rainfall (either at a representative raingauge within the catchment or as a catchment average for large catchments), summary statistics including peak flow, percentage runoff, lag time and probabilities for both the flow and the rainfall. A description and interpretation of each event is included in each summary sheet. The paragraphs below give a summary of the main characteristics of the flood events.

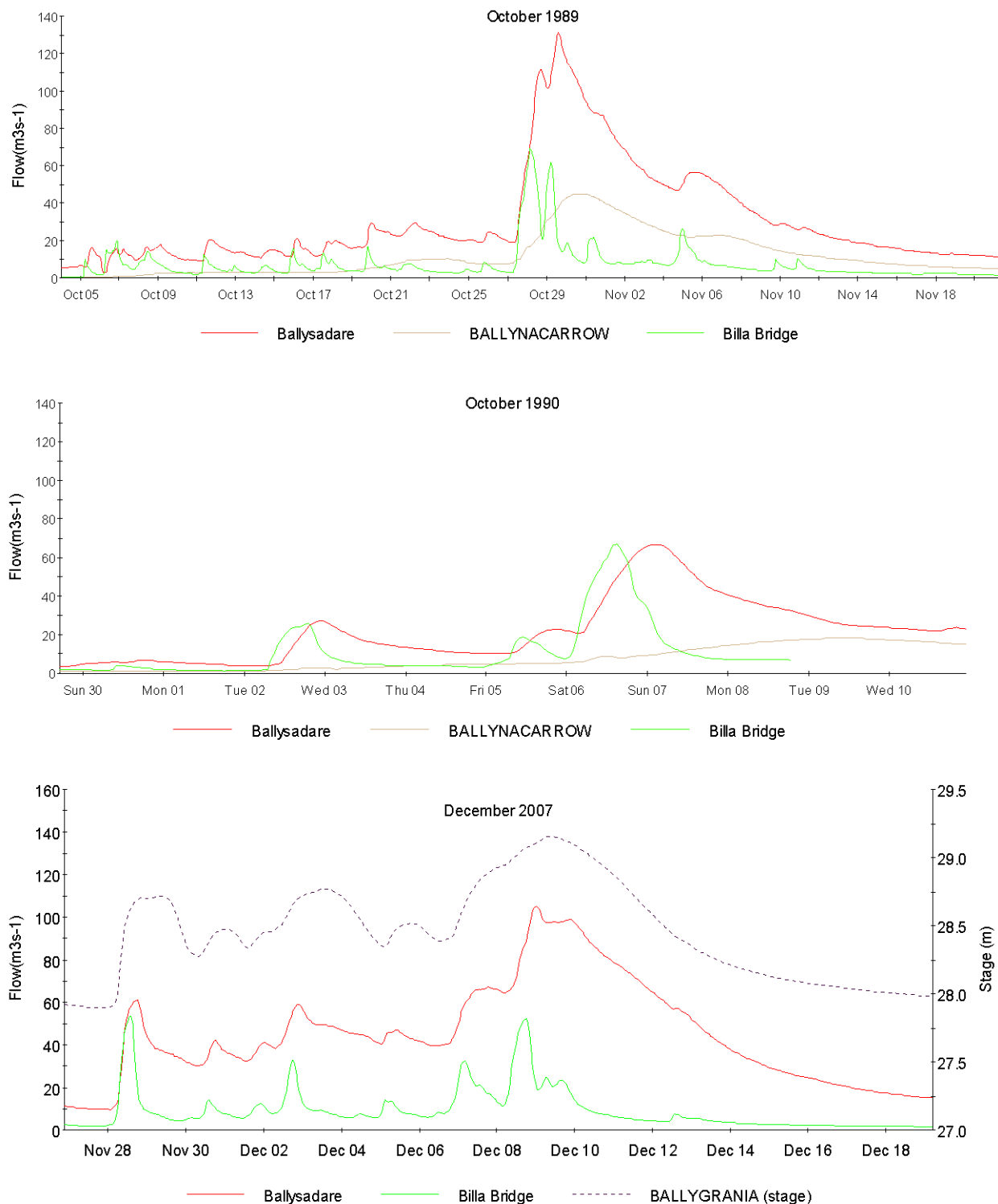
On the Bonet/Garvogue catchment, floods are fairly peaky apart from downstream of Lough Gill where the large amount of attenuation available in the lough leads to much more prolonged flood hydrographs. The lag time varies from under a day at Manorhamilton to 4-8 days at Sligo. Percentage runoff values are very high throughout the catchment, typically over 80%.

On the Ballysadare catchments a variety of flood hydrograph shapes is evident. On the Owenmore at Big Bridge and Ballynacarrow, flood events are prolonged due to the low gradient of the catchment. The much steeper Owenbeg shows a flashier response. At Ballysadare some events (e.g. November 1968) show a unimodal flood hydrograph with a duration of around a week. Others (e.g. November 2009) have a much more complex shape with numerous small flood peaks superimposed on a sustained period of high flows which lasts for several weeks. Presumably this reflects the different timings of contributions from the disparate tributaries. In November 1968 the rainfall was concentrated into a much shorter period than in the 2009 flood. Percentage runoff is high for all events analysed.

A multi-site event analysis was carried out for key river gauges in the UoM in order to demonstrate how different parts of the Ballysadare and Bonet catchments respond to a flood event.

For the Ballysadare catchment three events were analysed: December 1989, October 1990 and December 2007. Figure 3-6 shows the flow hydrographs at four gauging stations, namely Ballysadare downstream, Ballynacarrow, Billa Bridge and Ballygrania upstream (for which only limited stage record was available). The periods of data available at Ballynacarrow and Ballygrania do not overlap.

Figure 3-6: Multi-site event analysis for the Ballysadare catchment

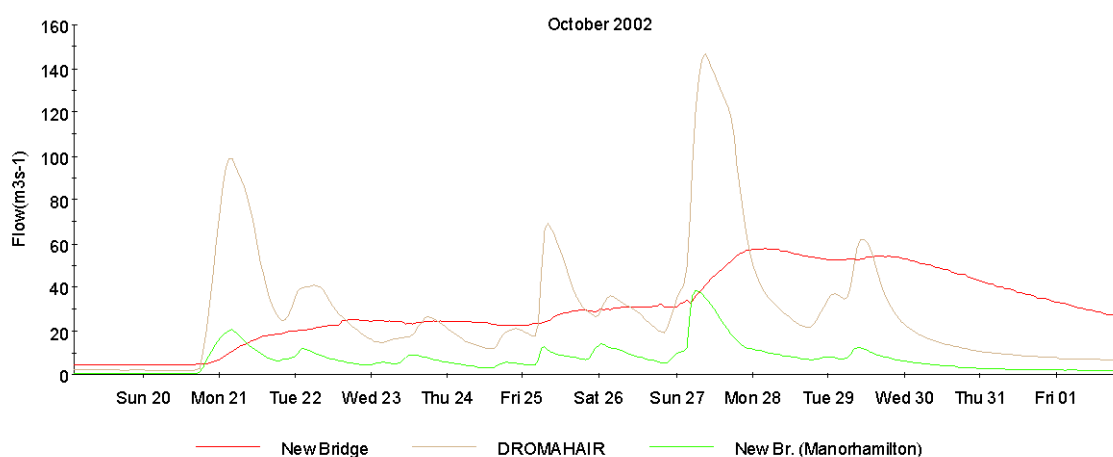


The Owenmore River at Ballynacarrow shows a prolonged flood peak with very subdued or absent smaller peaks, which are apparent at Billa Bridge and Ballysadare. This is due to the low gradient and large size of the Owenmore catchment. The flow stays high for over a week. The hydrograph at Billa Bridge shows the flashier response of the much steeper Owenbeg catchment, with peaks quickly dropping down in a day. At Ballysadare the hydrograph shows the signature of the flood peaks that occurred at Billa Bridge, but is much more prolonged due to flows arriving from more slowly responding parts of the catchment. The flow stayed high at Ballysadare for over 10 days.

The peak at Ballysadare is twice the peak at Billa Bridge for two of the analysed flood events. However, the October 1990 flood at Billa Bridge shows a very similar magnitude to that recorded at Ballysadare, with the Ballysadare River peaking just several hours after the Owenbeg at Billa Bridge. This occurs particularly on occasions when flows at Ballynacarrow (and probably at Ballygrania, too) are low and demonstrates the strong influence of the fast responding Owenbeg catchment. The River Unshin at Ballygrania seems to peak around a day after Billa Bridge. However, it seems peculiar that the peak flows at Billa Bridge and Ballysadare should have so similar magnitudes, particularly given that the Owenbeg catchment is only a small proportion of the whole Ballysadare catchment, unless the flow is attenuated upstream on the floodplain before reaching Ballysadare. As discussed in Section 3.6, this could also be due to uncertainty in high flow ratings.

In October 2002 a flood event occurred in the Garvoge/Bonnet catchment, ranking as the highest on record at the New Bridge (Manorhamilton) gauge, but not the highest downstream of Lough Gill. Figure 3-7 shows the hydrographs for the three gauges ordered from downstream at Sligo to upstream at Manorhamilton.

Figure 3-7: Multi-site event analysis for the Bonet catchment



The plot demonstrates the attenuating impact of Lough Gill on flows in the River Garvoge at New Bridge in Sligo. While the hydrographs are peaky with short lags (reflecting the hilly topography) upstream of the lake at the Dromahair river gauge and a further 15km upstream at New Bridge (Manorhamilton), the flow at New Bridge downstream is considerably attenuated by the lake and the peaks subdued. Lough Gill lies about 4km upstream of New Bridge and 5km downstream of Dromahair. The lag between the peak at Dromahair and at New Bridge at Sligo is over 15 hours and about 60% of the flow appears to be attenuated. This is a suspiciously large proportion of the flow, as discussed further in Section 3.6 below.

An analysis of the shapes of flood hydrographs is reported in Appendix E. The results of this will be used in the next stage of the study to derive design flood hydrographs as discussed below in Section 3.8.3. Appendix E contains a summary sheet for selected gauging stations showing a characteristic flood hydrograph derived by analysing a large number of observed events and fitting a mathematical function to an averaged hydrograph shape. Only gauging stations with flow records and rating curves are chosen. New Bridge at Sligo is excluded given the presence of Lough Gill gauge, only around 4km upstream. The characteristic flood hydrographs are compared with those derived from the Flood Studies Report design event method (the parameters of which are estimated from catchment descriptors). The FSR method has a potential advantage in that it may give more realistic hydrograph widths for ungauged catchments, since it accounts for the size of the catchment unlike the FSU method.

The two methods produce hydrographs that vary from quite similar on the steeper catchments to quite different elsewhere. On the low-gradient catchments, particularly those with substantial lakes, observed flood events are much more prolonged than those estimated by the FSR method. This is to be expected and it is possible to adjust the FSR hydrographs by carrying out lag analysis and/or flood routing calculations.

3.6 Analysis of Flood Peak Data

Analysis of flood peak data at eight flow gauging stations is recorded in Appendix F and summarised here. The flood level record at Ballygrania has also been included in the analysis described below.

The magnitude of estimated design flows will be based closely on analysis of local flood peak data where it is suitable, so it is important to develop an understanding of the statistical characteristics of the datasets. This includes testing for non-stationarity (i.e. trends or step changes) and detection and discussion of any outliers. Each gauge in the appendix is represented by a summary sheet showing a plot of the annual maximum flow series, analysis of trends and seasonality, flood frequency analysis (where the record is long enough), summary statistics for the largest floods and discussion of the data. The appendix also includes an analysis of flood volume data at one gauge, Ballysadare.

There are some long records of peak flows in this UoM. The longest records date back to 1945, on the Ballysadare River at Ballysadare and to 1957, on the River Bonet at Dromahair. There is also a record of peak water levels from 1955 on the Unshin River at Ballygrania.

There is considerable variation across the area in the date of the highest flood on record. On the Garvoge catchment, downstream of Lough Gill, the flood of November 2009 was the highest since the start of the record in 1975. Further upstream on the Bonet, at Dromahair, the October 1987 flood produced a higher peak flow than any other since 1957. However, this is likely to be due to the influence of the Bonet drainage scheme which was carried out between 1982 and 1992. On the Ballysadare catchment, the highest flood on record varies across the catchment: November 2009 was highest at Ballysadare, and November 1968 produced the highest water level at Ballygrania.

There is relatively little variation in the magnitude of flood peaks at most gauges. The highest flood on record does not generally appear as an outlier. At Ballysadare, the estimated AEP of the November 2009 peak flow is 1.3% which is quite modest given a record length of 65 years.

In terms of accumulated flow volumes, the November 2009 flood was the highest at Ballysadare for all durations analysed: 4, 8 and 16 days. For the longer durations it was outstandingly high, with an estimated AEP of 0.4% (i.e. a return period of nearly 300 years) for the 8-day duration.

Most gauges show a distinct seasonality, with annual maximum flows generally occurring between October and March. There is perhaps a wider spread of seasonality than seen on some other catchments in the Western RBD, which tend to flood mainly in autumn and early winter. The River Bonet/Garvoge has a less pronounced seasonality, with some significant floods recorded in summer months.

In terms of trends, there is a significant increasing trend in flood peaks at Ballysadare. This is mainly due to a sudden change in the magnitude of the floods occurring after around 1980. There is no history of arterial drainage on this catchment and the hydraulic control at the gauge is said to be stable. The reason for the change is not currently known. Delegates at the hydrology workshop held in April 2012 were unable to suggest any possible reasons.

Figure 3-8, over the page, compares annual maximum flows at four gauges on the River Bonet / Garvogue. Note that no flow data is currently available at Lough Gill after 2004. A striking feature of the plot is the massive attenuation in peak flows between Dromahair (upstream of Lough Gill) and the station at the outlet of Lough Gill. Despite a 30% increase in catchment area, peak flows drop by around half in many years. It can be seen that flows at New Bridge, Sligo are higher than at Lough Gill, typically by around 20%. This is unlikely to be correct given that the two gauges are only 4km apart and have very similar catchment areas. The Sligo gauge is included in the rating review, so it is possible that peak flows will be revised here during the next stage of the study.

Figure 3-9 compares annual maximum flows and levels at four gauges in the Ballysadare catchment. Ballysadare gauge is at the outlet into Ballysadare Bay and the other three gauges are on the three main tributaries of the Ballysadare River. No flow data is currently available at Ballygrania although a rating curve is due to be developed in the next stage of the CFRAMS. There are no distinct outliers in any of the flood peak series. The annual maximum flow at Ballysadare is similar to, and sometimes smaller than, the sums of the upstream peaks at Billa Bridge and Ballynacarrow, despite the fact that the catchment at Ballysadare is 65%

larger than the sum of the two upstream catchment areas. This may be mainly due to the very different typical timing of flood peaks at Billa Bridge (a rapidly-responding upland catchment) and Ballynacarrow (much slower response). Two of the gauges are included in the rating reviews so it is possible that the estimated flows will be altered.

Figure 3-8: Flood peak series at gauges on the River Bonet / Garvogue

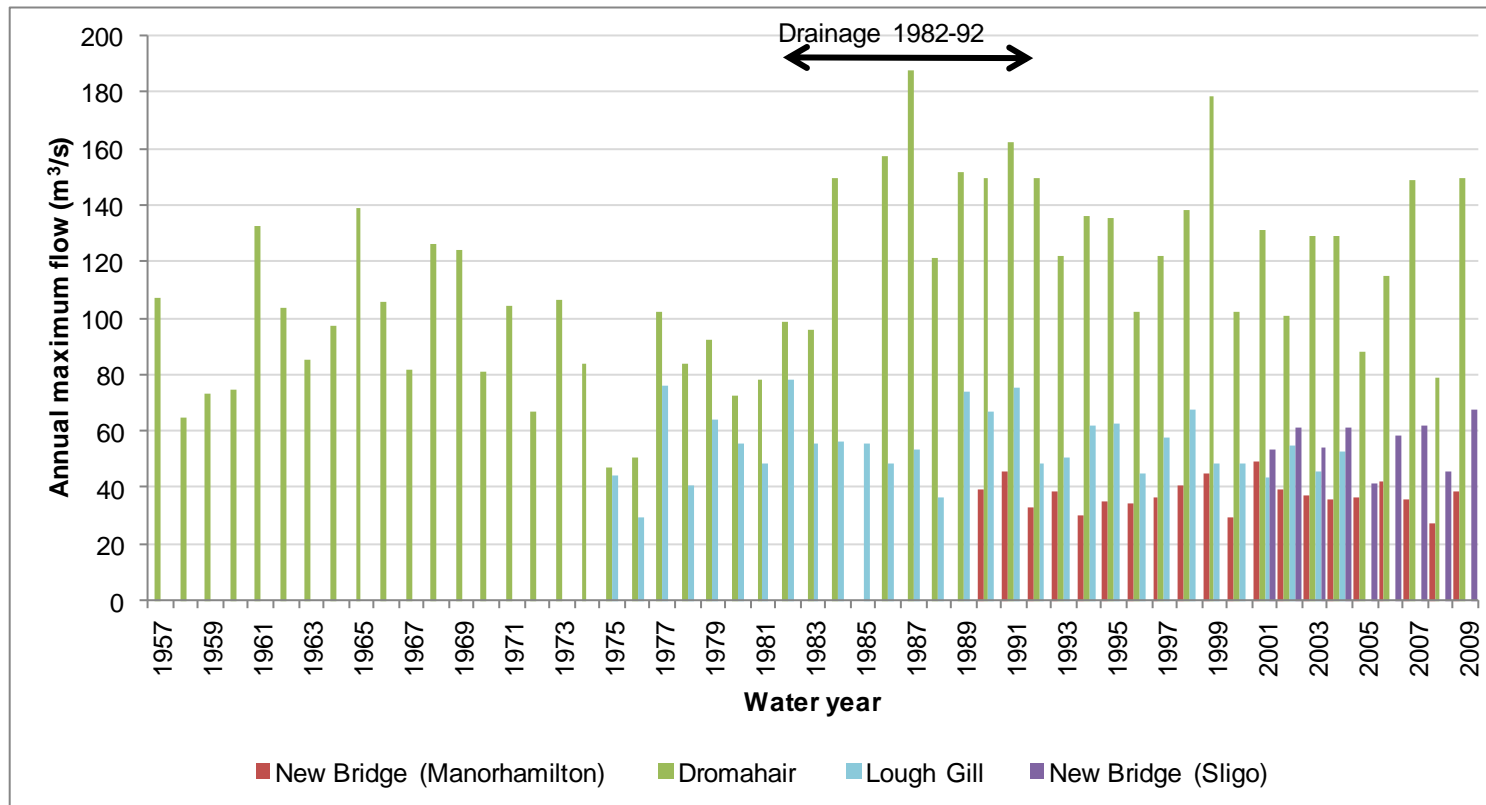
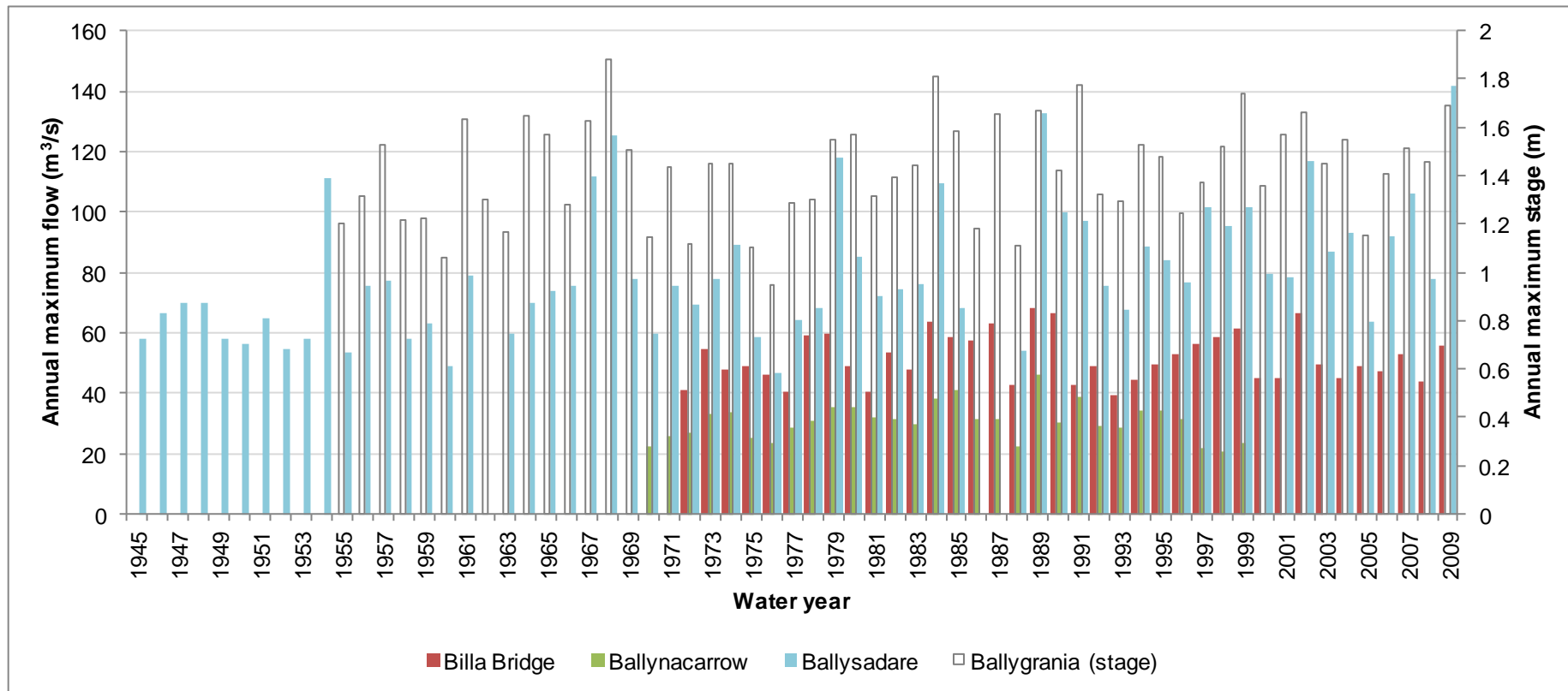


Figure 3-9: Flood peak series at gauges on the Ballysadare catchment



3.7 Analysis of flood impacts and longer-term flood history

Information on the impacts of both recent floods and events that pre-date the gauged records was collected from the sources listed in Section 2.4. The information was reviewed in order to provide relevant qualitative and, where possible, also quantitative information on the longer-term flood history in the area.

Only very limited information on flood history was available: two recent floods in Sligo and earlier events in Riverstown and Collooney. At Ballysadare, where the gauged record extends back to 1945, the highest recorded flow occurred in November 2009 and yet there were no reports of flood damage during this event.

A chronology of flood events is given in Appendix G, along with two visual time-lines (one for the Ballysadare and one for the Bonet catchment) which summarise the findings in terms of relative magnitudes of different events, as assessed from both gauged data and the historical review.

Given the paucity of historical flood information there is limited potential to incorporate it into a flood frequency analysis. In any case, for the Bonet catchment the value of earlier information is limited by the fact that the drainage scheme (1982-92) altered the hydrology of the catchment.

3.8 Method Statement for Flood Estimation

3.8.1 Needs of the study

The specification calls for estimation of design flood parameters for eight AEPs, ranging from 50% to 0.1%. There are eight AFAs. Design flows are needed for:

- The Garvoge River at Sligo along with minor watercourses draining to Sligo Harbour, some with quite urbanised catchments
- The Owenmore and Owenbeg Rivers at Manorhamilton
- The Ballysadare River, plus minor tributaries, at Ballysadare
- The Owenmore and Unshin Rivers, plus minor tributaries, at Collooney. Note that this is a different Owenmore River to that listed above at Manorhamilton.
- The Owenbeg River, plus tributaries, at Coolaney
- The Douglas and Unshin Rivers at Riverstown
- Minor watercourses at Ballymote, labelled Ballymote and Carrigan's Upper
- Two minor watercourses at Gorteen

The specification calls for hydrological estimation points (HEPs) to be located upstream, downstream and centrally at each AFA and at all gauging stations. Points must also be located upstream and downstream of tributaries contributing more than 10% of flow in the main channel with no greater spacing than every 5km. These guidelines have been followed wherever possible when locating these points, in addition to adding a point wherever the catchment area increases by 10%.

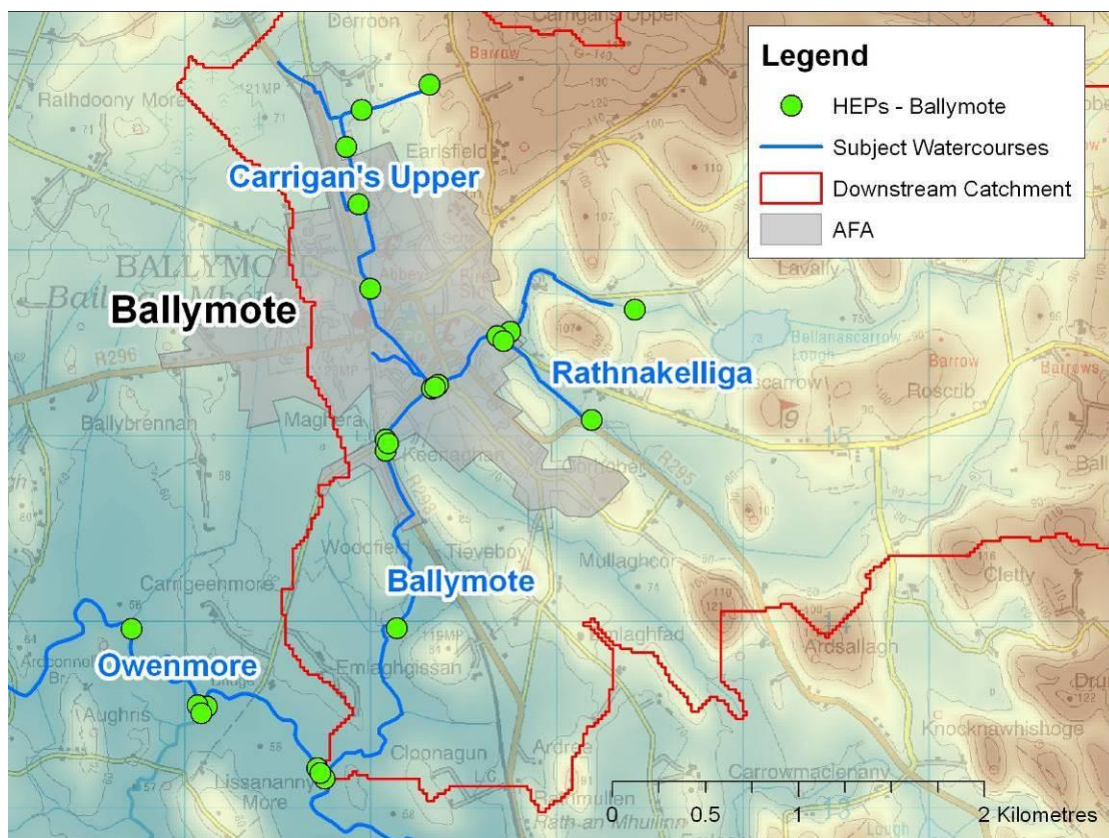
However, in certain locations the guidelines have been adapted. For example, until the hydrological analysis is undertaken it is not possible to ascertain which tributaries contribute 10% of main channel flow; therefore HEPs are defined for those tributaries that contribute greater than 10% of catchment area. Elsewhere it may be the case that the location of a point at the upstream extent of the AFA is not necessary, when another point is located nearby (i.e. at a tributary confluence). It is also not practical to add a flow estimation point everywhere the catchment increases by 10% on very small tributaries - this would result in an unmanageable number of points. Where this is the case a minimum point spacing of 200m has been employed.

The following table and maps record the number of HEPs and their locations associated with each AFA.

Table 3-1: Hydrological estimation points associated with each watercourse

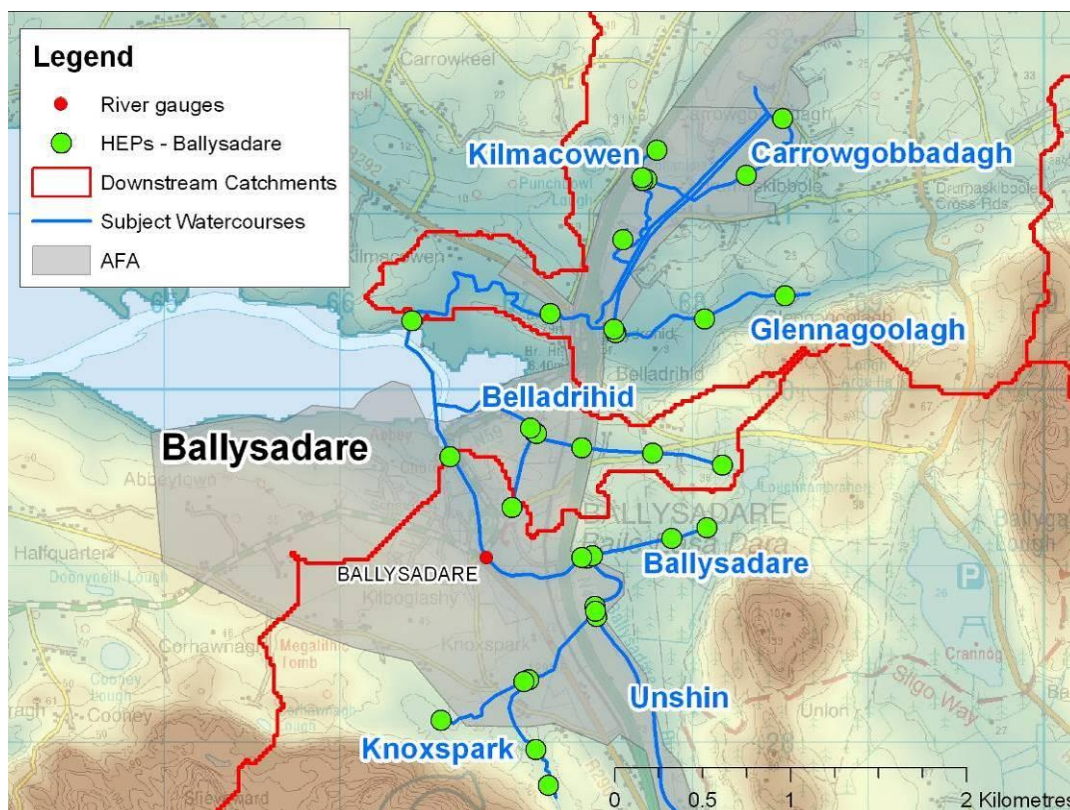
| Watercourse | Priority | Associated AFAs | Number of HEPs |
|--------------------------|-------------|------------------------------------|----------------|
| Owenmore | HPW and MPW | Gorteen, Ballymote, Collooney | 35 |
| Gurteen | HPW | Gorteen | 10 |
| Gorteen | HPW | Gorteen | 6 |
| Ragwood | HPW | Gorteen | 2 |
| Ballymote | HPW and MPW | Ballymote | 9 |
| Rathnakelliga | HPW | Ballymote | 2 |
| Carrigan's Upper | HPW | Ballymote | 6 |
| Owenbeg | HPW and MPW | Coolaney | 12 |
| Halfquarter | HPW | Coolaney | 2 |
| Rathbarran | HPW | Coolaney | 4 |
| Knockbeg East | HPW | Collooney | 4 |
| Unshin | HPW and MPW | Riverstown, Collooney, Ballysadare | 14 |
| Douglas | HPW and MPW | Riverstown | 4 |
| Ardcomber | HPW and MPW | Riverstown | 3 |
| Belladrihid | HPW | Ballysadare | 5 |
| Knockuldoney | HPW | Ballysadare | 2 |
| Ballysadare | HPW | Ballysadare | 4 |
| Glennagoolagh | HPW | Ballysadare | 5 |
| Carrowgobbadagh | HPW | Ballysadare | 5 |
| Kilmacowen | HPW | Ballysadare | 2 |
| Knoxspark | HPW | Ballysadare | 4 |
| Kilboglashy | HPW | Ballysadare | 2 |
| Bonet | MPW | Manorhamilton | 12 |
| Owenmore (Manorhamilton) | HPW | Manorhamilton | 7 |
| Curraghfore | HPW | Manorhamilton | 5 |
| Brackary | HPW | Manorhamilton | 4 |
| Sligo | HPW | Sligo | 2 |
| Knappagh | HPW | Sligo | 6 |
| Tobernaveen | HPW | Sligo | 4 |
| Willsborough | HPW | Sligo | 10 |
| Carrowlustria | HPW | Sligo | 2 |
| Doonally | HPW | Sligo | 2 |
| Lisnalurg | HPW | Sligo | 3 |
| Barroe | HPW | Sligo | 2 |

Figure 3-10: Ballymote HEPs



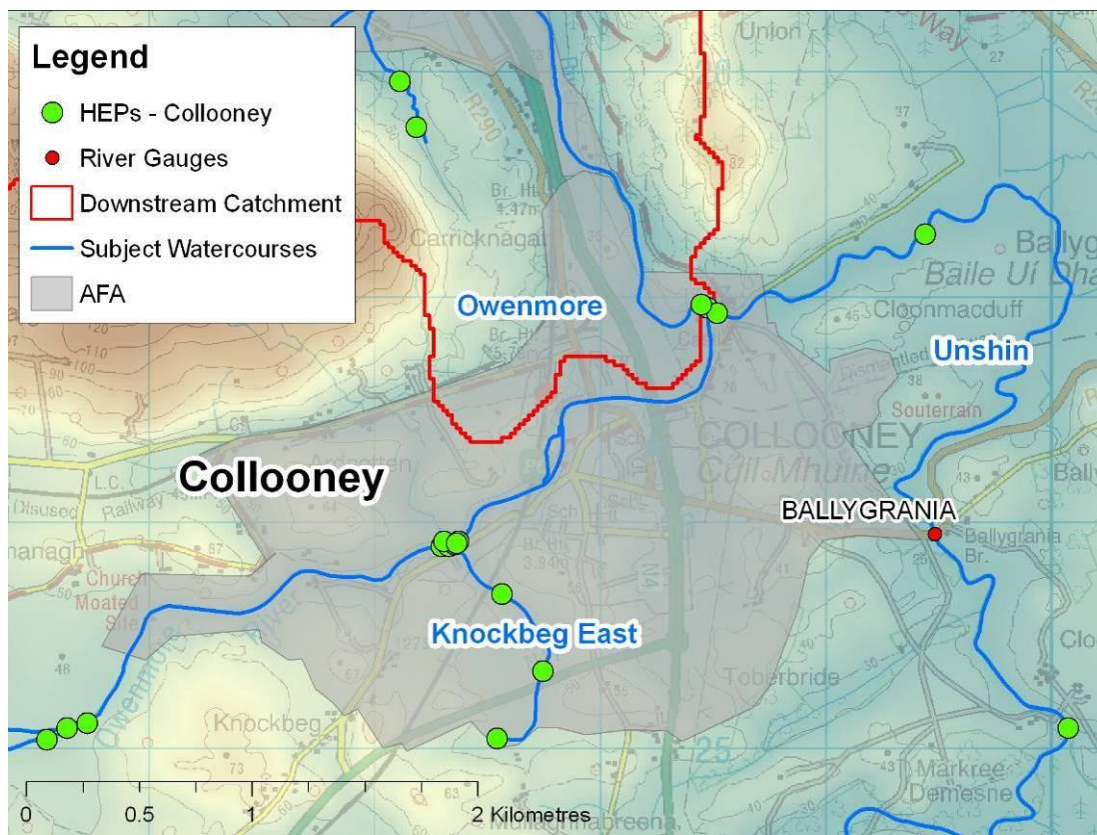
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Figure 3-11: Ballysadare HEPs



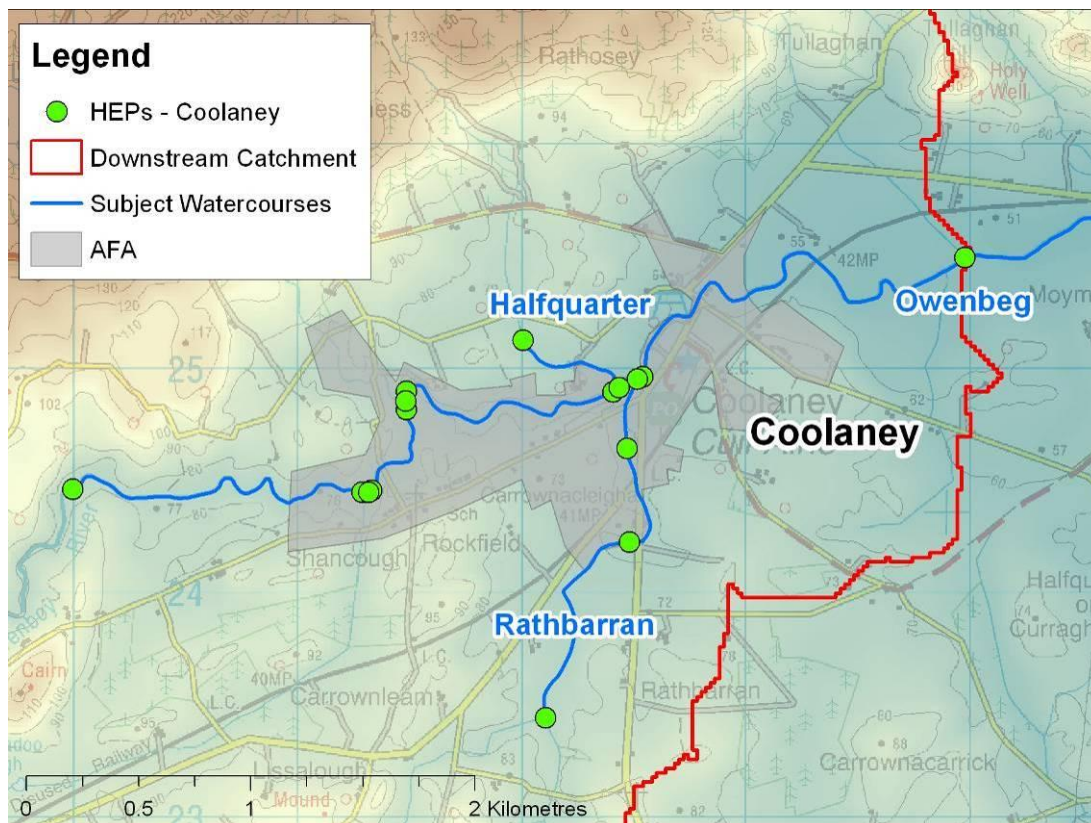
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Figure 3-12: Collooney HEPs



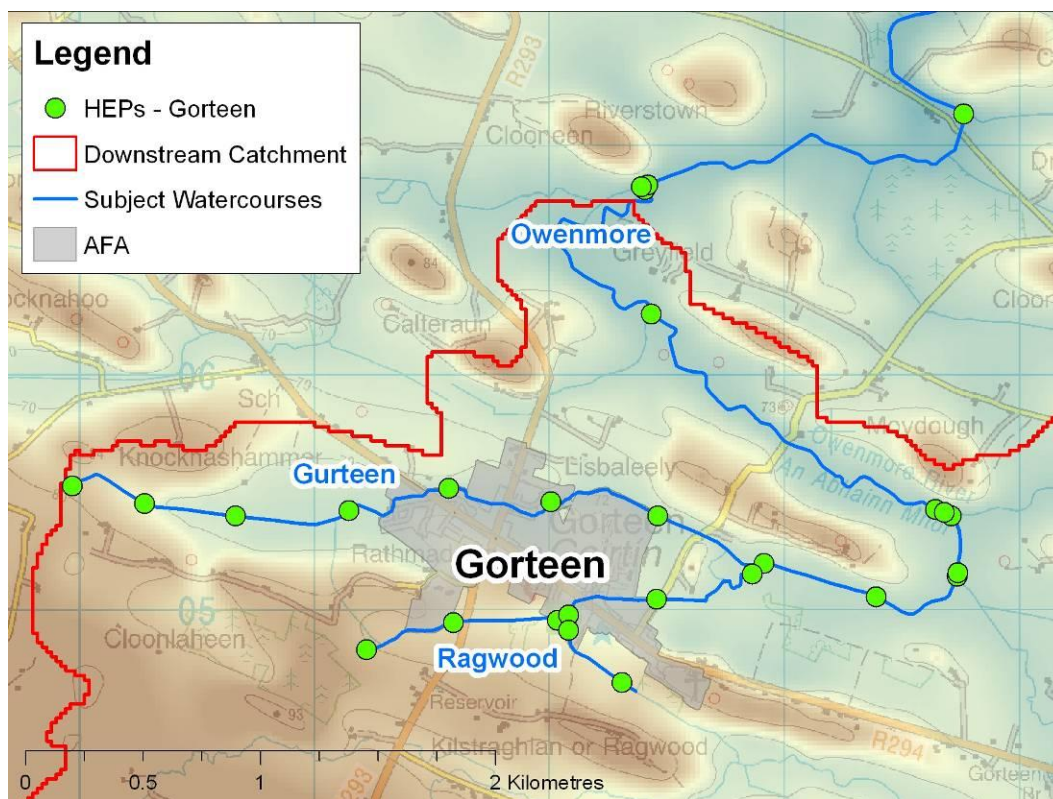
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Figure 3-13: Coolaney HEPs



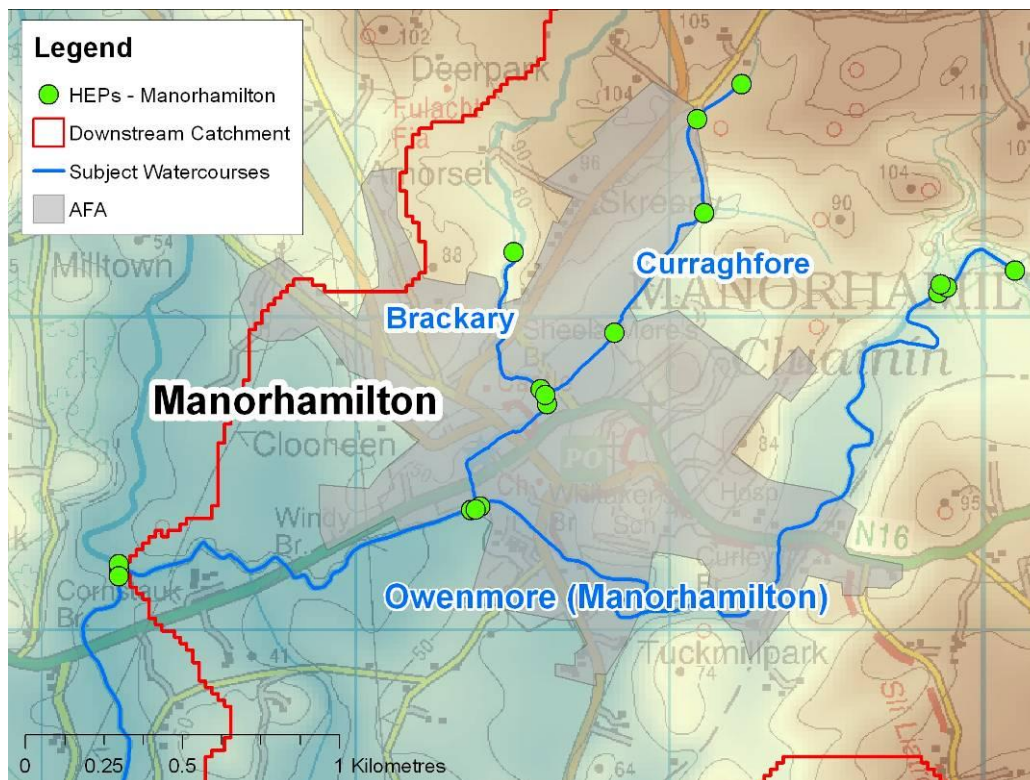
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Figure 3-14: Gorteen HEPs



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Figure 3-15: Manorhamilton HEPs



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Figure 3-16: Riverstown HEPs



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Figure 3-17: Sligo HEPs

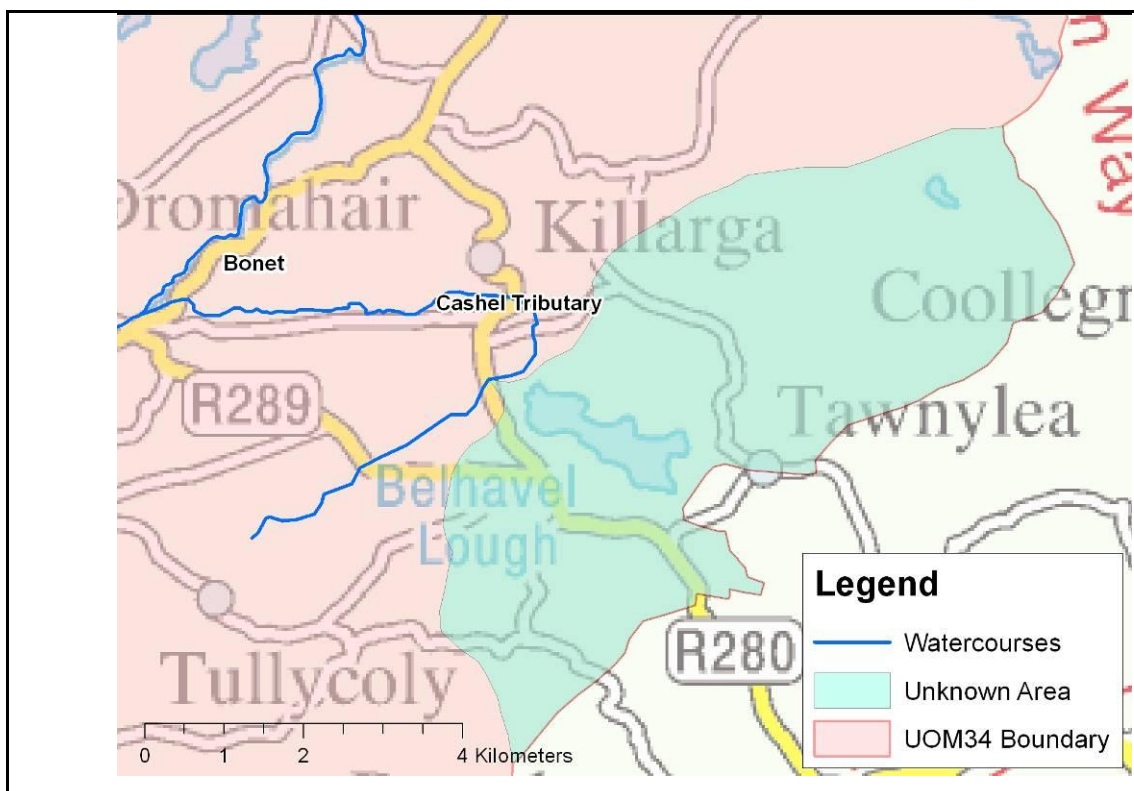


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Catchment boundaries for each HEP have been obtained from the information supplied by OPW (which were derived for implementation of the Water Framework Directive). These have been checked using Arc Hydro, a specialised component of the ESRI Arc Map program for defining catchment boundaries. The program was run using the 20m DTM, supplied by OPW. The areas of the catchments produced from this process have been checked against those provided.

For UoM35 these are mostly well matched. However the checks revealed an error on a tributary of the Bonet. The Bonet is joined by the Cashel tributary east of Dromahair. FSU catchment descriptors on the Cashel tributary give this watercourse a total area of 23km² although there is a significant area (18 km²) in the upper catchment which has not been accounted for (see Figure 3-18). This includes the land draining to Belhavel Lough. The river centreline dataset in this location shows two watercourses flowing from the watercourse; one into the Cashel channel and one east out of the UoM area. Information received from local authority staff at the CFRAM hydrology workshop held in April 2012 indicated that the eastern outlet from Belhavel Lough was blocked by a landowner over 100 years ago and thus the lough does now drain west into the Bonet catchment. Therefore an additional 18 km² will be added to the catchment area of HEPs along the Cashel tributary and downstream on the Bonet. The UoM boundary does not need to be altered.

Figure 3-18: Cashel catchment boundary correction



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3.8.2 Hydrometric data available

Two of the eight AFAs have gauging stations on site. Another two have gauges some way downstream. Another, Collooney, has upstream gauges which may be of use in flood estimation. The other three AFAs are on small or medium-sized ungauged watercourses.

The principal gauging stations likely to be used in the flood estimation are:

- At Sligo there are two gauges (Lough Gill and New Bridge) with peak flows available from 1975. The rating equation at New Bridge is being reviewed as part of this CFRAM study. The existing rating can be treated with high confidence up to QMED although there is some concern over differing peak flows at the two gauges during the overlapping period of record. The drainage scheme carried out from 1982-1992 may limit the value of the earlier data.

- At Ballysadare there is a gauge on the Ballysadare River with a long flow record back to 1945. The rating equation is being reviewed as part of this CFRAM study. The existing rating can be treated with fairly high confidence up to QMED.
- At Collooney there is a gauge some 3km upstream on the Unshin River at Ballygrania. However, the main river flowing through Collooney is the Owenmore. The Owenmore is gauged upstream at Ballynacarrow, although the catchment here is rather different from that at Collooney because it excludes the Owenbeg River which joins the Owenmore shortly upstream of Collooney. At Ballynacarrow there are flood peak data from 1970-1999 and they are classed as good quality in the FSU dataset.
- At Coolaney there is a gauge 4km downstream at Billa Bridge. Annual maximum flows are available from 1971. The rating equation is being reviewed as part of this CFRAM study. The existing rating is rather uncertain at high flows owing to a shortage of check gaugings.
- Although there is no gauge at Riverstown there is one 10km downstream at Ballygrania that is likely to be relevant for flood estimation. There is currently no flow data here but a rating is due for development during this study. Annual maximum levels are available back to 1955.

There are no nearby flow gauges at Manorhamilton, Gorteen or Ballymote.

3.8.3 Considerations on choice of method

There is a variety of types of catchment for which design flows are needed.

On the lower parts of the catchments, at Sligo, Ballysadare and Collooney, floods are prolonged and some are difficult to regard as single events because they occur as a result of sequences of rain storms. Although the primary impact of a flood may be due to the peak water level that is reached, secondary damage is largely the result of the duration of flooding and relates to the time that economic activity is suspended and to the cumulative social, structural and agricultural impacts of long term inundation. As river basin size increases, secondary damage becomes an increasing proportion of total damage (Anderson et al., 1993⁴). A consequence is that accurate estimates of flood durations and volumes may be important on these catchments.

In contrast, the catchments at Manorhamilton and Coolaney are short and steep with little storage available and thus floods are much briefer and can be characterised more fully by their peak flow and level.

The catchments at Gorteen and Ballymote are small and ungauged. Riverstown has a medium-sized catchment, with two watercourses joining. The larger one, the Unshin River, is likely to be substantially influenced by Lough Arrow.

These varied characteristics call for a variety of flood estimation techniques. Where there are flow gauges at or near to AFAs, the natural choice of method will be to estimate both design peak flows and design hydrographs from locally recorded data where its quality and length of record are adequate. Peak flows will be estimated from QMED derived from at-site gauged data or by data transfer using upstream or downstream gauges as pivotal sites where possible. Flood growth curves will be derived from a combination of single-site and pooled analysis, with comparisons made between the two at all gauges with at least 10 years of good-quality annual maximum flow data.

For ungauged watercourses, QMED will be estimated from catchment descriptors. Although this initial estimate will be adjusted wherever possible, it is unlikely that suitably representative pivotal catchments will be found for the small watercourses and so flood estimates at Gorteen and Ballymote are likely to be highly uncertain. Flood growth curves for such watercourses will be based on pooled analysis.

Several AFAs are substantially influenced by attenuation due to lakes. This is the case at Sligo, but here the effects of Lough Gill are implicitly represented in the flow data recorded at the outlet

⁴ Anderson, R.J., dos Santos, N. and Diaz, H.F. (1993) An analysis of flooding in the Parana/ Paraguay River Basin. Laten Dissemination Note 5. Latin America and Caribbean Technical Dept. Environment Division. World Bank. Washington DC.

of the lake, and so it is not considered necessary to carry out flood routing calculations. However, for estimating design flows on the Unshin at Riverstown it may be beneficial, at least for comparative purposes, to route a flood hydrograph (estimated from the FSR rainfall-runoff method) through Lough Arrow. If this is to be carried out, it will be necessary to extend the MPW reach around 6km upstream from Riverstown to Lough Arrow to allow routing of the hydrograph along the river.

Characteristic flood hydrographs for flow estimation points at and near gauging stations will be based on analysis of observed hydrographs (Appendix E). At ungauged locations, or for setting inflows to the model from tributaries, a variety of methods for defining characteristic flood hydrographs will be tested. These will include:

- Deriving a characteristic hydrograph using the parametric method from FSU work package 3.1 in which a hydrograph (standardised to have unit peak) is represented by a combined gamma and exponential distribution whose parameters are estimated from catchment descriptors. A potential drawback of this approach is that it can result in hydrograph durations that are not realistic given the size of the catchment.
- The above approach with parameters adjusted by reference to any nearby similar catchments for which observed flood hydrographs are available.
- The Flood Studies Report rainfall-runoff method, in which hydrograph shapes are determined largely by the characteristics of the catchment, i.e. time to peak and annual average rainfall.

3.8.4 Summary

The table below summarises the relative confidence that can be expected in the design flows at each AFA.

Table 3-2 Summary of expected confidence in design flows at each AFA

| AFA | Flow gauge nearby? | Quality of high flow data? | Length of record? | Remarks | Expected relative confidence in design flows |
|---|---|---|---|---|---|
| Sligo | Yes (New Bridge within AFA) | Moderately high and should improve | Fairly long (2001 to present) but may be compromised by drainage scheme | | Moderately high but decreasing for low AEPs due to unusual catchment (lake influence) |
| Manorhamilton | No | n/a | n/a | | Low |
| Ballysadare | Yes (Ballysadare within AFA) | Moderately high and should improve | Very long (1945 to present) | | High |
| Collooney | Some distance (Ballynacarrow 8.5km upstream of AFA) | Moderately high according to FSU | Fairly long (1970 to present) | | Moderate |
| Coolaney | Yes (Billa Bridge 4km downstream of AFA) | Moderately low but should improve | Fairly long (1972 to present) | | Moderate, perhaps high if rating extension goes well. |
| Riverstown | Some distance (Ballygrania 10km downstream of AFA) | No flows currently but rating due to be developed | Fairly long (1973 to present) | May also consider flood routing through Lough Arrow | Moderately low, perhaps moderately high if rating development goes well. |
| Ballymote | No | n/a | n/a | Small catchments | Very low |
| Gorteen | No | n/a | n/a | | Very low |
| Notes: This table concentrates on the main watercourse passing through each AFA and does not include minor tributaries. The confidence of design flows on these smaller watercourses is likely to be low. | | | | | |

The hydrology report will include an assessment of the uncertainty of the design flows. This will be based on the results of statistical calculations (to evaluate confidence limits) and sensitivity tests (to assess the impact of assumptions such as the choice of flood frequency distribution).

3.9 Applying Design Flows to the River Models

Inflows for the river models will be specified in accordance with the guidance developed for FSU work package 3.4. Several of the proposed model reaches are long and modelled flood hydrographs are likely to alter significantly due to attenuation effects.

The FSU guidance includes advice on dividing models into reaches and setting inflows to models. One of the main considerations is the location of gauging stations within the model reach, because it is at these sites that the greatest confidence can be placed in the design flows.

As suggested in the guidance, we propose to first try a design run of the entire length of each model, with inflows set as described below. If this does not give an adequate representation of design peak flows and flood durations throughout the model reach, we will divide the model into several reaches, each of which will be run separately.

The approach for setting model inflows will be guided largely by the location of gauging stations, as recommended in the guidance. For AFAs with nearby gauges, the general aim will be to adjust model inflows until the peak flow in the model gives an acceptable match to the preferred hydrological estimate at the gauge. As a starting point, the magnitude of inflows from tributaries will be set using the exceedence probabilities given in the FSU guidance, which depend on the degree of similarity between the catchments of the main river and the tributary. Where necessary, lateral inflows will be applied to keep the modelled flow in the river at a realistic value on long model reaches where there are no major confluences. Where possible, the use of intervening areas (which are not true catchments) will be avoided as advised in the FSU guidance on river modelling.

The timings of inflows will be specified either using the regression equation developed in FSU work package 3.4 or else from the FSR rainfall-runoff method if it is decided that the latter gives a more realistic representation of hydrograph shapes for ungauged inflows.

The approach of adjusting model inflows in order to match a preferred hydrological estimate of the peak flow is not recommended as suitable in all cases by the FSU guidance. One exception might be at Riverstown, if it is decided to derive design flows on the River Unshin using a flow routing model as discussed above.

3.10 Coastal Flood Levels and Joint Probability Analysis

The term extreme still water sea-level refers to the level that the sea is expected to reach during a storm event of a particular AEP due to a high tide and the passage of a storm surge. Extreme still water sea-level estimates will be provided by OPW and no new estimates will be produced as part of this study. It will be necessary, however, to derive design tidal-graphs to quantify how sea-levels are expected to change through time during an extreme event. These tidal-graphs will form the principal tidal boundary for the coastal and estuarine flood inundation models. Within UoM35, coastal modelling is required for the Sligo and Ballysadare AFAs only.

Derivation of the design tidal-graphs for this study will involve consideration of the following:

- The peak magnitude of the event, determined by the extreme still water sea-level.
- The shape and magnitude of the underlying astronomical tide. This is likely to be based on a Mean High Water Spring or Highest Astronomical Spring tide cycle. The source of these data will be tidal predictions from the nearest port to the coastline or estuary of interest. JBA has a licence for the TotalTide software from which these data can be obtained.
- The shape and magnitude of the storm surge. A design storm surge profile will be derived using available local tide gauge data, or will be based on a standardised surge shape if no suitable local data exist
- The timing of the storm surge relative to high tide. Complex shallow flow processes referred to as tide-surge interaction normally result in the peak of a storm surge occurring on the rising or falling limb of a tide. It will be important to account for this phenomenon in the derivation of the design tidal-graphs to ensure that they are suitably conservative.

Whilst it is often the case that a flood event will be dominated by either extreme river flows or extreme sea-levels, there are also many occasions where it is the combination of these two driving forces that leads to flooding. The CFRAM studies do not call for an exhaustive evaluation of all of the possible combinations of fluvial flow and extreme sea-level that could occur. However, it will be important to ensure that all models in areas where fluvial flows and tidal levels combine will have appropriately scaled downstream tidal boundary and upstream flow boundary.

Within UoM35 only Sligo and Ballysadare have both fluvial and tidal risks being evaluated and may require some evaluation of the joint probability issues. For these AFAs, we will evaluate an appropriate combination of fluvial flow and extreme sea-level. For the fluvial flood design simulations, the extreme variable will be the flow (primary variable) and a moderately extreme sea-level (secondary variable) will be applied. For the coastal flood design simulations, the extreme variable will be the sea-levels (primary variable) and a moderately extreme fluvial boundary (secondary variable) will be applied. Our analysis will involve evaluating the appropriate level of 'extremeness' for the secondary variable. Where available, this assessment

will include the use of coincident recorded sea-level and flow data from which correlation factors can be derived. These correlation factors, in conjunction with the return period growth curves for each variable, will be input into a joint probability tool to generate combined variable pairs. We will then evaluate which pair of variables should be used for each simulation and discuss this with the OPW. As part of this evaluation, we will consider the sensitivity of the modelled water levels to the variable pairs chosen.

3.11 Future Environmental and Catchment Changes

The impact of possible future changes within the AFAs will be assessed using two scenarios, the mid-range future scenario (MRFS) and high-end future scenario (HEFS). These will account for changes in climate and land use. The impact of these changes on flood flows will be simulated as follows:

- Increasing urbanisation. We propose to estimate future urban extents using current development plans. By dividing the extent of areas allocated for development by the total area of each catchment it will be possible to calculate an incremental increase in the urban extent catchment descriptor. Where this increase is significant, design flows will be increased accordingly using the urban adjustment formula developed in Flood Studies Update work package 2.3.
- Changes to level of afforestation (clearing and new planting). The specification calls for changes to the parameters of the FSR rainfall-runoff method, SPR and Tp. This method will not be used to derive the magnitude of peak flows, but it will be possible to calculate the effects of altering these parameters on the magnitude of flows by using the IBIDEM method developed as part of the Flood Studies Update research.
- Increase in rainfall and river flows due to climate change. Peak flows will be increased by 20% and 30% for the mid-range future scenario and high-end future scenario, respectively.

3.12 Hydro-Geomorphological Assessment

Fluvial hydro-geomorphology encompasses both the physical habitat created by water (flowing or still) over the structural template or geomorphology of a river and the processes acting to change or maintain this physical template. Due to its direct link to biotic health and sustainability through the creation and maintenance of ecological habitats, hydro-geomorphological status and improvement now forms a fundamental component of the WFD and associated River Basin Management Plans. All river channels are reactive, responding to changes in the catchment by eroding and depositing sediment along its course. Reactivity levels vary dramatically with some river types being more prone to certain types and rates of change than others. Regardless of the rate, change will impact directly on flood risk, potentially altering the conveyance potential of the channel and increasing the probability of flooding. As such an understanding of potential river response over time is invaluable in sustainably managing a river system and a hydromorphic audit provides the form and process information necessary to achieve this.

The assessment of hydro-geomorphology in the CFRAM is specifically aimed at the influence on flood risk within the study area. This part of the work was started with the Flood Risk Review site visits where hydro-geomorphological features were mapped and photographed. Hydromorphological issues were associated with AFAs linked to siltation, disturbance to spawning gravels, changes in nutrient conditions, floodplain habitats, coastal habitats, engineered structures and agricultural intensification.

The Western CFRAM SEA Constraints Study reviewed available information and highlighted that a large number of sites have been identified in the Western River Basin Management Plan as suffering from hydromorphological pressures. Some of these sites are undergoing remedial works whilst others have targeted actions to allow them to achieve good ecological status. The Western CFRAM SEA Constraints Study noted that all proposed flood risk management measures must be compatible with any WFD requirements to restore the natural morphology of waterbodies 'at risk' due to structural alterations. Historic and potential future alterations to water bodies have the potential to instigate siltation and shoaling of coarser material which can compromise flood capacity. A hydromorphic assessment is needed to ensure WFD compliance. Locally too activities in the channel have the potential to disturb spawning gravels. River

floodplain form and function are linked to river dynamics and must be considered during flood alleviation and engineered structure design and coastal habitats must be assessed if impacted.

The hydromorphological assessment within the Western CFRAM will continue in parallel with the hydraulic modelling to consider the impact of hydro-geomorphology on flood risk. The assessment will use available or readily derivable historic data to place channel form and activity in a long-term context. This will be linked to evidence on erosion or deposition derived from the visual inspections of watercourses, surrounding areas and key assets conducted as part of the Western CFRAM flood risk review. Controlling processes will also be assessed using a combination of existing data (hydrology, topography, soil, sub-soil, geology, etc.), and, where necessary, site visits. The following stages of hydromorphic audit are proposed:

- Conditions in the catchment affecting the channel morphology and dynamics, to include review of sediment sources and their significance.
- Historic behaviour of the river channel, including use of historic mapping.
- Gross channel type character of the channel and related channel dynamics.
- The hydromorphology of the channel through each AFA, including review of the Flood Risk Review information and possible additional site visits. Particular emphasis on whether hydro-geomorphology issues will influence flood risk in each AFA.
- Consideration of whether potential options for sediment control may impact the hydraulic modelling and whether they may be worth pursuing within the FRMP stage.

3.13 Coastal erosion mapping

For AFAs at risk of coastal flooding there is a requirement to prepare future scenario erosion hazard mapping in respect of the MRFS and HEFS. Such future scenario erosion hazard mapping shall include two erosion prediction lines for each scenario; one for the year 2050 and the other for year 2100.

OPW remain flexible on the exact methods used to provide coastal erosion maps. As referred to in the brief, the Bruun Rule is a useful starting point for coastal recession assessment, but we do not recommend its “default” use without location specific consideration as many coastlines are not well suited to its application. Existing annual erosion rates derived under the ICPSS will be a valuable indication of likely erosion impacts.

We recommend that final decisions on erosion assessment methods are after a further review period while more detail about the AFAs is gathered. Local evidence may provide a similarly efficient and much more reliable basis for assessment.

Depending on local circumstances and the assessment approach used, the results could be subject to a good deal of uncertainty. We would recommend capturing this within the assessment, perhaps in bands (high, medium and low with associated band widths for each). These could be added to the erosion contours to form broader erosion hazard zones on maps rather than firm lines. This may be helpful in communicating risk and data uncertainty.

A decision making process will then need to be documented and implemented to determine where further assessment is needed – i.e. whether measures should be considered as part of the CFRAM process to tackle the erosion issue identified, and also how this may link in with adjacent fluvial or tidal responses.

Within UoM35 the coastal AFAs are Sligo and Ballysadare. In both these instance the coastline is rocky which does not lend itself to a Bruun Rule type approach (Figure 3-19). In these AFAs historical trend analysis and future change extrapolation, in conjunction with the ICPSS data, LIDAR, and information on local geology, will likely be used for coastal erosion mapping.

Figure 3-19: UoM 35 typical coastline



Sligo headland coastline



Ballysadare coastline

4 Proposed Hydraulic Analysis

This chapter provides detail on the proposed hydraulic modelling for each AFA and MPW. This gives information on the type and location of modelling being proposed and quality of likely outcomes.

4.1 Scope

This section develops the proposed hydraulic modelling methods for the HPWs in each AFA to include the incorporation of information from the Flood Risk Review to derive site specific approaches. The work described goes up to delivery of Hydraulics Report where baseline models are produced. Use of the models for options assessment and defence failure are to be reported on in the Preliminary Options Report at a later stage in the project. The development of MPW models is also discussed.

4.2 Level of detail

We recognize that the hydraulic analysis needs to be robust and must provide models that can be used for subsequent studies with only minor modification. The basis of our hydraulic modelling is to approach model build in a highly-structured way to deliver the maximum levels of efficiency. Routine processes (such as incorporation of survey data) will be highly automated with QA checks undertaken to review the output of the automated process, e.g. check selection of cross sections against survey drawings, check long section plots, check survey levels against LIDAR etc. Modeller time will be concentrated on determining the optimum model scheme and checking and calibrating the model. All the hydraulic modelling will be undertaken by JBA modellers.

Model schematisation will be influenced by:

- Data availability (DTM resolution and coverage, gauge location etc)
- The results of the hydrological analysis
- The physical characteristics of the watercourse (gradient, attenuation, type of hydraulic structures)

4.3 Development of fluvial hydraulic models

On HPWs the standard modelling approach will be a 1D-2D schematisation. We propose to use ISIS for the 1D element of the modelling. Where overland flows, or floodplain storage are significant to the hydraulic operation of the catchment, the ISIS model will be developed into a linked ISIS-TUFLOW model, using available LIDAR data for the overbank model domain. An appropriate maximum cell area will be chosen depending on the topography and the resolution of the DTM.

MPWs will be modelled as 1D hydraulic models using ISIS. Cross sections will be spaced more widely than HPWs (typically 500m) but structures will be included. Floodplains will be modelled using extended cross sections, the floodplain part of which will come from the best available DTM.

Key constraints on developing the fluvial hydraulic models will be the delivery of the topographic survey data for the river channels and LIDAR DTM for the floodplain. Production of the final design flows are also a constraint on finalising the modelling and mapping, although model build can begin before flows are available.

4.4 Development of coastal flooding models

We propose to use TUFLOW for the 2D coastal modelling using LIDAR data for the overbank model domain. An appropriate cell area will be chosen depending on the topography and the resolution of the DTM. Tidal boundaries giving water level over several tidal cycles will be developed to use as inputs to the models.

Wave overtopping modelling may be required in some AFAs. Overtopping analysis would be applied across coastal defences protecting specific AFAs where required. We have a number of tools (e.g. EuROTop) to allow analysis of wave overtopping input into the 2D coastal flood models. Wave overtopping calculation is dependent on provision of near shore wave data in the locations of interest.

Where fluvial and coastal risk is present in the same AFA it is proposed that direct coastal flooding will be modelled independently from the fluvial risk. Any risk from tidal flooding along the river channel will also be included within the fluvial modelling. A suitable cut off between using the coastal and fluvial model will need to be determined, e.g. at a bridge.

Key constraints on developing the coastal hydraulic models will be the delivery of the LIDAR DTM for the floodplain.

4.5 Hydraulic model calibration and sensitivity testing

The process of model proving is essential to provide evidence that the model results are believable and defensible. It also gives confidence the model can be used for development of options. Model proving will include model calibration and sensitivity testing.

Model calibration will largely be dependent on the availability of appropriate data. Comment on this is made in the following section for each AFA but is likely to include gauged data and other historic flood event data.

Sensitivity testing will be undertaken on all models to ensure model behaviour is appropriate for changes in key model parameters, including roughness, flow, boundary conditions and afflux at key structures.

4.6 Quality Assurance of Hydraulic Models

Review and quality assurance is a key part of the hydraulic modelling process, which begins at the start of the modelling exercise when a senior modeller and the unit manager will be involved in the development of each model from initial schematisation stage. They will ensure the model development and related problems can be progressed efficiently.

The modeller will complete a detailed technical check file for each model. An early version of this document, capturing any assumptions and specific approaches, will assist the review process before modelling has proceeded too far.

All hydraulic models and model outputs will be reviewed by suitably senior hydraulic modellers and the reviews clearly documented. Within UoM35 the technical review process will be overseen by technical lead, Dr Chris Smith (Principal Analyst) with UoM specific input from Sam Willis. Additional support where necessary for specific technical aspects, e.g. Dr Mark Lawless for coastal issues, Duncan Faulkner for issues relating hydrology to the modelling.

The JBA reviewer will use the check file and the model itself to investigate model performance and outputs. A technical review certificate will be completed for each model documenting the checks carried out. Typical checks will include:

- Appropriate design flows applied in model.
- 1D component schematised and constructed correctly, including channel structures.
- 2D component schematised and constructed correctly.
- Model outputs appear appropriate.
- Model run statistics are appropriate.

A traffic light colour coded system is used in our model reviews to highlight good practice (green), observations (yellow) and problems (red).

4.7 Evaluation of AFA hydraulic modelling requirements

In the following sections, the hydraulic models required for each AFA and MPW are described in some detail, including data requirements, approach to the modelling and consideration of the confidence in model outputs. Table 4-1 below gives a summary of information for each AFA.

Table 4-1: Summary information for each AFA

| AFA | Estimate FRI score from Flood Risk Review | Fluvial | Coastal | Key Issues of Note |
|---------------|---|---------|---------|---|
| Ballymote | 310 | Yes | No | Impact of blockage at structures. |
| Ballysadare | 150-300 | Yes | Yes | High velocities and impact of sea level rise. |
| Collooney | 100-300 | Yes | No | High velocities and impact of blockage at structures. |
| Coolaney | 150-300 | Yes | No | Impact of blockage at structures. |
| Gorteen | 200-300 | Yes | No | Informal defence structures and impact of blockage. |
| Manorhamilton | 50-250 | Yes | No | High velocities and impact of blockage at structures. |
| Riverstown | <250 | Yes | No | Impact of blockage at structures. |
| Sligo | >250 | Yes | Yes | Joint probability events may be an issue. |

Our experience shows that accuracy of the model output must be matched to the decision being made, and without good data it is a false economy to believe that detailed scheme designs can be abstracted from preliminary models.

In order to manage expectations in the outcomes of the CFRAM, and to guide the level of detail appropriate at each stage of the assessment, we have developed a scoring system which is based on an evaluation of the likely reliability of model outputs, and the likely viability of a flood management scheme. Based on our knowledge at this early stage of the assessment, we have assigned a score for both elements to each AFA.

The two scores are:

- Confidence in achievable model results: this considers the availability of calibration data, and complexity of the flood processes within the AFA;
- Expected scheme viability: this is based on the type of receptors at risk, and points to the likely outcome of a cost benefit assessment.

The scores are combined to give a model output ranking for the AFA which will help the OPW and the Project Group to focus their efforts during any reviews. The model output ranking is broken down into its generic grades in Table 4-2, and for each AFA we have completed a table (provisional assessment of deliverables) which shows how the two scores have been compiled from the various contributing factors.

An example of the application of the score is as follows; where little data is available to calibrate the model, and the flood mechanisms are complex then it is unlikely that immediate investment in structural flood measures in the next 5 years should be implemented, unless there is a clear past flood history. In order to improve the model further calibration data will be required, and therefore the works will become a lower priority in the final FRMP.

Table 4-2: Output ranking grades to be applied to each AFA

| AFA Model Output Ranking | Description | 'Confidence in achievable model results' Score [A score of 18 is considered the pivot point which would indicate whether the model will be suitable to support significant investment] | 'Expected Scheme Viability' Score [A score of 8 is considered a pivot point which would indicate whether a scheme will be justified in the short term plan period] |
|--------------------------|---|---|---|
| A | Availability of model calibration data which will support a good modelling assessment. Good justification to promote scheme works in the short term. High scheme viability (based on flood risk impacts and scale of management options) | < 18 | <8 |
| B | Some uncertainty in model output due to limitations in data is expected. Further investigation likely to be required before scheme works can be delivered in the longer term. High scheme viability (based on flood risk impacts and scale of management options), so may suggest earlier intervention. Therefore undertake a few iterations of the modelling processes, and seek more local knowledge of past events | >= 18 | < 8 |
| C | Good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term Low scheme viability (based on flood risk impacts and scale of management options). | < 18 | >= 8 |
| D | Low confidence in model output and unlikely to improve with more modelling. Limited evidence base to progress works Low scheme viability (based on flood risk impacts and scale of management options) with scheme in the short term. These AFAs can be completed more directly. | >= 18 | >= 8 |

4.8 Ballymote

4.8.1 Hydraulic modelling assessment

Ballymote will be modelled as a single fluvial hydraulic model using ISIS-TUFLOW. The watercourses to be modelled are shown in Figure 4-1. A more detailed map of the AFA with additional details is included at the rear of the report (Figure 4-2).

Figure 4-1: Ballymote modelling overview map

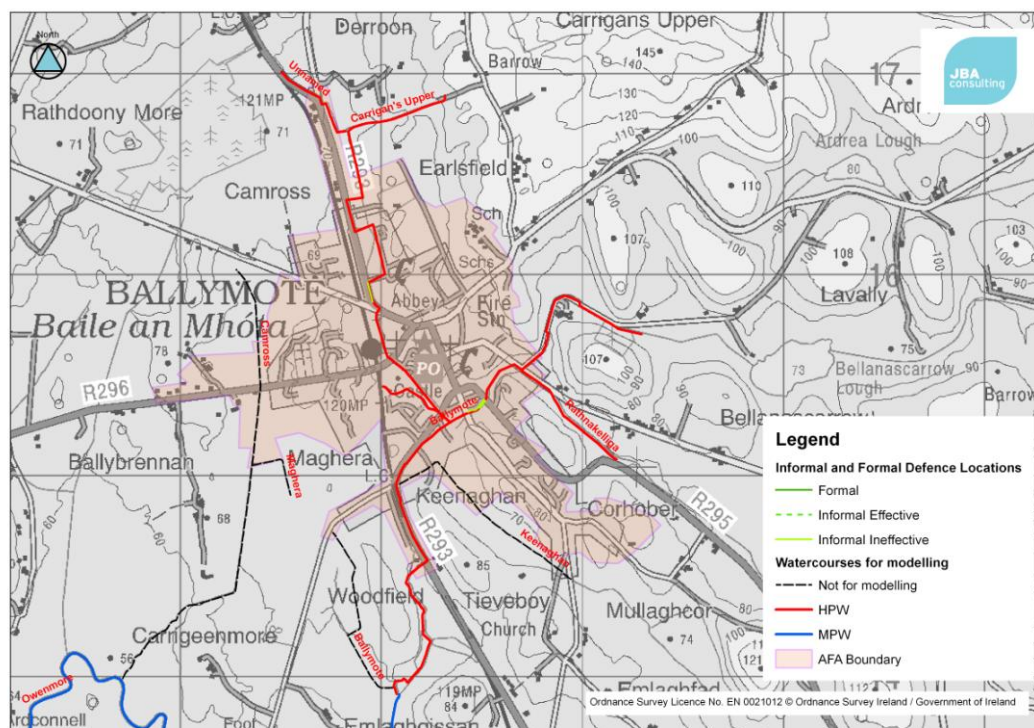


Figure 4-2: Ballymote modelling details map - at rear of report

Table 4-3 and Table 4-4 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-3: Ballymote assessment of model requirements

| A - General Modelling Key Considerations | |
|--|---|
| (a1) Number and length of watercourses within each hydraulic model | <p>Carrigan's Upper 2.9km Ballymote 3.1km Carrownanty 0.3km Rathnakelliga 0.7km</p> <p>The Keenaghar and Camross watercourses are not being modelled as they have a catchment area to the AFA boundary of less than 1km²</p> |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Very Low |
| (a3) Detail the available records and operation of the closest gauge site (s). | <p>The two nearest recording gauges are Big Bridge and Templehouse Demesne located on the Owenmore River upstream and downstream of the Ballymote Stream tributary respectively.</p> <p>Big Bridge is a flow and level gauge for which records are available between 1956 and 1969. Templehouse Demesne is a level only gauge for which records are available between</p> |

| | |
|---|--|
| | <p>1987 to Present.</p> <p>The Ballymote staff gauge is located on the Ballymote Stream at the downstream limit of the AFA. Records are available between 1980 and 2002.</p> <p>The Bellanascarrow staff gauge is located on the Ballymote Stream upstream of the AFA near the mouth of the Bellanascarrow Lough. Records are available between 1990 and 1995.</p> |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | Calibration data is limited to the staff gauge data discussed above. |
| (a5) Describe the boundary conditions and the data required. | <p>The upstream limit of the model has been selected based on local topography to minimise the width of the flood plain.</p> <p>The downstream boundary will be a normal depth boundary.</p> |
| (a6) Number and type of hydraulic structures present within the model? | 9 Bridges and 4 Culverts. |
| (a7) What are the key hydraulic controls at the site? | The watercourses within the AFA are relatively small and the multiple small bridges along each of these are likely to be of hydraulic importance in the local vicinity. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | The size of the majority of structures suggests they may be prone to blockage and sensitive to assumptions. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is within the town of Ballymote and is likely to contain properties. Potential secondary flow paths have also been identified. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | No. Some walls but all are ineffective. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | N/A |
| (b3) Is a wave overtopping analysis likely to be required? | N/A |
| (b4) Is a joint probability analysis likely to be required? | N/A |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally distributed across multiple locations within Ballymote. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | Some of the floodplain on the left bank of the Ballymote downstream has been zoned for residential development. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The AFA is located a significant distance upstream of the Ballysadare AFA and strategic impacts are expected to be minimal. |

Table 4-4: Ballymote provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|---|---|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 5 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 4 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 4 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 4 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 4 |
| Total Score | | | | | | 21 |
| Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances. Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal. | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 2 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 4 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 3 |
| Total Score | | | | | | 9 |
| Scores 3 to 7 – The site conditions suggest a flood management scheme is viable. Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan. Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited. | | | | | | |
| AFA model output Ranking | D: Low confidence in model output and likely low scheme viability would suggest that this AFA will need further investigation and/or better local data on past flood events to be collected. A programme of monitoring may be recommended. | | | | | |

There is limited historical evidence of flooding to the site and in bank data is likely to prove the focus of the calibration. The Ballymote staff gauge downstream of Ballymote provides the only usable data for in bank calibration. The data provided incorporates a series of spot gaugings only and calibration will therefore be limited to a possible verification of the rating curve in the model at this location. To allow detailed model calibration it will be necessary to install a subdaily recording raingauge in conjunction with a recording level gauge to provide sufficient data.

4.8.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Ballymote topographic survey data is within National Survey Contract 6, work package 7. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-5: Ballymote programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.9 Ballysadare Northern Model

4.9.1 Hydraulic modelling assessment

Ballysadare will be modelled as two separate models. The first model will include the flat area to the northern of the AFA boundary covering mainly industrial areas. The second model will include the main Ballysadare River and the town of Ballysadare located to the south of the AFA.

This section covers the Ballysadare Northern model. An ISIS-TUFLOW fluvial model will be used to represent the site with a tidal boundary at the downstream end to represent the tidal flood risk. The watercourses to be modelled are shown in Figure 4-3. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-4.

Figure 4-3: Ballysadare northern site modelling overview map

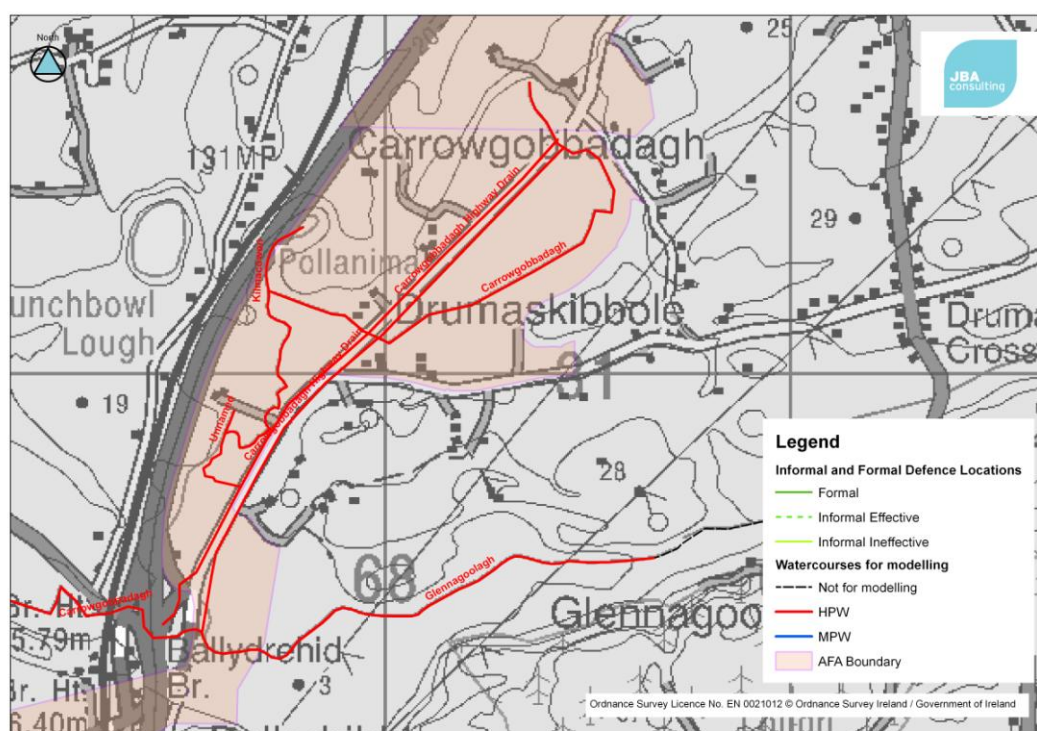


Figure 4-4: Ballysadare northern site modelling details map - at rear of report

Table 4-6 and Table 4-7 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-6: Ballysadare northern model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|--|
| (a1) Number and length of watercourses within each hydraulic model | Carrowgobbadagh 4.2km Carrowgobbadagh Highway Drain 3.10km Glennagoolah 1.6km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Low but flood risk is predominantly tidal |
| (a3) Detail the available records and operation of the closest gauge site (s). | There are no gauges on this watercourse. |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | There is no available data for calibration. The majority of flood risk is associated with tidal flooding and this may have been prevented following the works at the N4 junction roundabout. |

| | |
|---|--|
| (a5) Describe the boundary conditions and the data required. | Limited evidence was observed of the Carrowgobbadagh watercourse and it is suspected this may have been diverted into the Highway Drains. The upstream boundary is therefore expected to reflect the upstream limit of the drains with the downstream boundary dictated by a still water tidal level. |
| (a6) Number and type of hydraulic structures present within the model? | 21 Bridges and 4 Culverts. |
| (a7) What are the key hydraulic controls at the site? | The key hydraulic control at the site is expected to be the culvert beneath the railway bridge. This structure is the furthest downstream and is expected to control tidal inflows to the site. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | The low velocity of flows through the site associated with the tidal influence suggests that structures will not be overly sensitive to modelling assumptions. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is expected to be narrow around the channel. There is limited complexity in the floodplain. If the channel has been realigned into the highway drains a 1-D model is feasible. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | There are no known defence assets on this watercourse. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | Yes, flood risk is predominantly tidal. |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | A coastal model is not required. Inflows into the downstream limit of the site are controlled by the railway culvert; tidal flood risk will be adequately represented in the fluvial model. |
| (b3) Is a wave overtopping analysis likely to be required? | Wave overtopping will not be required. |
| (b4) Is a joint probability analysis likely to be required? | Fluvial flood risk is expected to be negligible and as such a joint probability analysis is unlikely to be required. |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally located along the length of the site. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | There is potential for further development alongside the road. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The majority of flood risk is tidal and therefore there are limited expected impacts outside of the immediate vicinity of the site. |

Table 4-7: Ballysadare northern model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|--|--|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 2 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 5 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 3 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 1 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 2 |
| Total Score | | | | | | 13 |
| <p>Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results</p> <p>Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances.</p> <p>Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal.</p> | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 3 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 4 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 2 |
| Total Score | | | | | | 9 |
| <p>Scores 3 to 7 – The site conditions suggest a flood management scheme is viable.</p> <p>Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan.</p> <p>Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited.</p> | | | | | | |
| AFA model output Ranking | C: Low scheme viability (based on flood risk impacts and scale of management options) with good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term. | | | | | |

Whilst there are significant uncertainties with the flows at this site the predominant source of flood risk is expected to be tidal. There is significantly greater confidence in the tidal levels and the fluvial element in a combined event should be relatively small, as such the uncertainty here should not overly impact the results.

4.9.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Ballysadare northern model topographical survey

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data is within the Western CFRAM Survey Contract 2, work package 1. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-8: Ballysadare northern model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.10 Ballysadare Southern Model

4.10.1 Hydraulic modelling assessment

Ballysadare will be modelled as two separate models. The first model will include the flat area to the northern of the AFA boundary covering mainly industrial areas. The second model will include the main Ballysadare River and the town of Ballysadare located to the south of the AFA.

This section covers the Ballysadare Southern model. An ISIS-TUFLOW fluvial model will be used to represent the site. The site also includes a gauge site; the developed model will be used to review the rating at the gauge site. The watercourses to be modelled are shown in Figure 4-5. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-6.

Figure 4-5: Ballysadare southern site modelling overview map

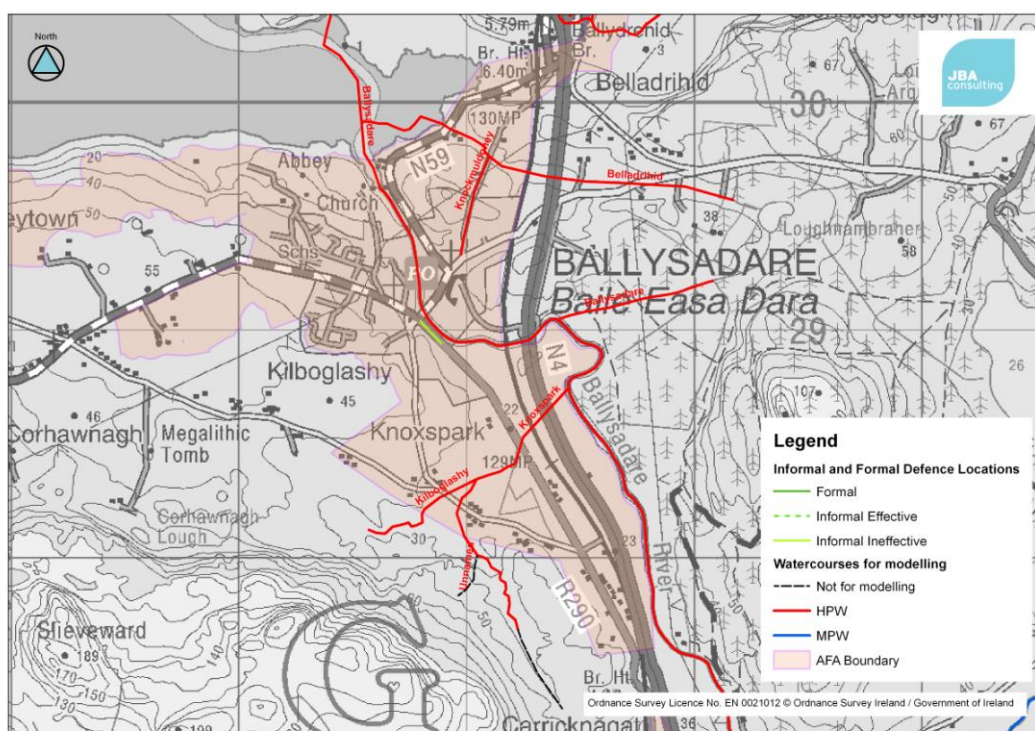


Figure 4-6: Ballysadare northern site modelling details map - at rear of report

Table 4-9 and Table 4-10 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-9: Ballysadare southern model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|--|
| (a1) Number and length of watercourses within each hydraulic model | Ballysadare 5.6km Belladrihid 1.8km Knockmuldoney 0.5km Knoxspark 1.8km Kilboglasy 0.6km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | High |
| (a3) Detail the available records and operation of the closest gauge site (s). | The Ballysadare flow and level gauge is located within the centre of the AFA. Records are available from 1945 to Present. The Ballygrania level gauge is located upstream of the AFA. |

| | |
|---|--|
| | Continuous data is only available at this gauge from 2007. |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | The largest event on record occurred in 2009 during which both gauges were in operation. The presence of the two gauges provides an opportunity to calibrate the upstream reaches of the model to a high order event. There is no further calibration data. |
| (a5) Describe the boundary conditions and the data required. | The Ballysadare River has wide floodplains and the location of the upstream limit of the model will be dictated by the local topography. Flows will be determined from the local gauge site analysis. The downstream boundary will be a still water tidal profile. |
| (a6) Number and type of hydraulic structures present within the model? | 8 Bridges, 1 Culvert and 3 Weirs. |
| (a7) What are the key hydraulic controls at the site? | The key hydraulic control at the site is the significant weir at the downstream end. The N59 Road Bridge may affect flows at higher return periods. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | The weir is unlikely to be particularly sensitive to modelling assumptions for upstream levels given the presence of the gauge site, however due to its length, approximately 450m of cascading falls, it will be difficult to generate high confidence in water levels downstream of the upstream crest. The N59 is a multiple arch bridge and build up of debris may be an issue. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is expected to be narrow around the channel. There is limited complexity in the floodplain. The high and potentially variable velocities at the site would require a 2-D model for detailed analysis. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | There are no known defence assets on this watercourse. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No, there is a significant gradient at the downstream limit of the watercourse minimising tidal flood risk. |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | A coastal model is not required. |
| (b3) Is a wave overtopping analysis likely to be required? | Wave overtopping will not be required. |
| (b4) Is a joint probability analysis likely to be required? | The height of the weir at the downstream limit provides a clear demarcation of the tidal boundary. |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | A couple of local sites were identified in the flood risk review along the watercourse. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | No known development pressures. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The sizes of the flood risk areas are limited; major implications to downstream sites within the AFA are therefore considered unlikely. |

Table 4-10: Ballysadare southern model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|--|--|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 2 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 3 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 3 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 3 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 2 |
| Total Score | | | | | | 13 |
| <p>Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results</p> <p>Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances.</p> <p>Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal.</p> | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 1 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 5 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 2 |
| Total Score | | | | | | 8 |
| <p>Scores 3 to 7 – The site conditions suggest a flood management scheme is viable.</p> <p>Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan.</p> <p>Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited.</p> | | | | | | |
| AFA model output Ranking | C: Low scheme viability (based on flood risk impacts and scale of management options) with good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term. | | | | | |

There are sufficient flow gauges on the Ballysadare River both within the AFA and upstream to provide sufficient data with which to calibrate the model. There will be a lower confidence associated with model results on the surrounding tributaries but flood risk at these sites is likely to be limited.

4.10.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Ballysadare southern model topographical survey

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data is within the Western CFRAM Survey Contract 1, work package 5. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-11: Ballysadare southern model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.11 Collooney Model

4.11.1 Hydraulic modelling assessment

Collooney will be modelled as a single fluvial hydraulic model using ISIS-TUFLOW. The watercourses to be modelled are shown in Figure 4-7. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-8.

Figure 4-7: Collooney modelling overview map

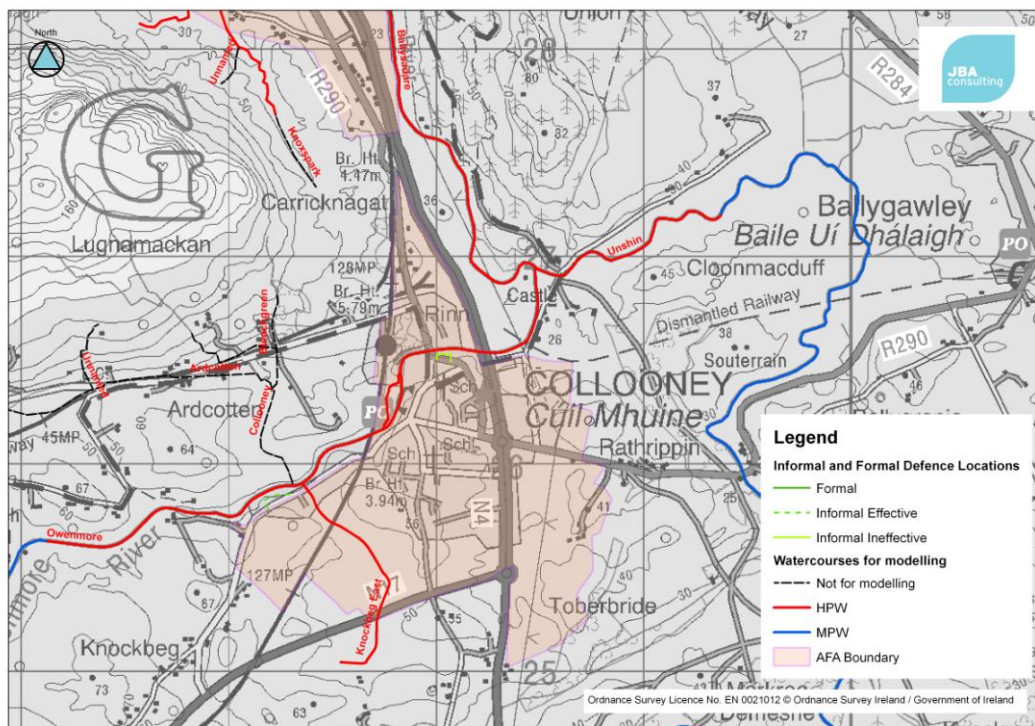


Figure 4-8: Collooney modelling details map - at rear of report

Table 4-12 and Table 4-13 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-12: Collooney model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|---|
| (a1) Number and length of watercourses within each hydraulic model | Unshin River 1.1km Knockbeg East 1.2km Owenmore 3.2km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Moderate |
| (a3) Detail the available records and operation of the closest gauge site (s). | Two recording gauges exist upstream of the AFA, both with flow and level data available. A gauge at Billa Bridge has records available from 1971 to Present and a gauge at Ballynacarrow has records available from 1970 to 1999. The Collooney staff gauge is located on the Owenmore at the downstream limit of the AFA. Records are available between 1979 and 2006. |
| (a4) Detail the available historical data for model calibration and state any limitations associated | Some descriptions of flood risk within the area associated with the August 1986 flood are available. |

| | |
|---|---|
| with this data. | Some key areas have also been reported by the council as at risk of flooding. |
| (a5) Describe the boundary conditions and the data required. | <p>The upstream boundary will be located downstream of the Owenmore and Owenbeg Rivers and flows will be dictated by the upstream gauges on each of these watercourses.</p> <p>The downstream boundary will be a normal depth boundary. The Ballysadare AFA model can be used to review boundary sensitivity.</p> |
| (a6) Number and type of hydraulic structures present within the model? | 12 Bridges, 1 Culvert and 5 Weirs. |
| (a7) What are the key hydraulic controls at the site? | The key hydraulic control is the Mill Falls in the centre of the site. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | Downstream of the falls the R290 Road Bridge is a multi arch Bridge and may be prone to blockage. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is expected to be narrow around the channel. Flow velocities however are a critical issue along this watercourse and any out of bank flows will need to be assessed within a 2-D model for confidence. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | A single defence exists on the right bank of the Owenmore River as detailed in Section 2.6, it is not expected this will require a breach analysis. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | N/A |
| (b3) Is a wave overtopping analysis likely to be required? | N/A |
| (b4) Is a joint probability analysis likely to be required? | N/A |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally located at local sites along the length of the AFA. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | No known development pressures. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The expected areas of flood risk are limited and the effects downstream of any option would be expected to be negligible, however some appraisal of implications for the Ballysadare site would be required. |

Table 4-13: Collooney model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|--|--|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 3 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 4 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 4 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 3 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 3 |
| Total Score | | | | | | 17 |
| <p>Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results</p> <p>Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances.</p> <p>Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal.</p> | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 1 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 4 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 3 |
| Total Score | | | | | | 8 |
| <p>Scores 3 to 7 – The site conditions suggest a flood management scheme is viable.</p> <p>Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan.</p> <p>Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited.</p> | | | | | | |
| AFA model output Ranking | C: Low scheme viability (based on flood risk impacts and scale of management options) with good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term. | | | | | |

Two flow gauges are available upstream of the catchment on which the hydrology will be developed. The Collooney staff gauge provides a series of spot gaugings within the AFA between 1979 and 2006 and calibration using this data will be limited to a possible verification of the rating curve in the model at this location.

To allow detailed model calibration it will be necessary to install a recording level gauge within the AFA against which to assess the response of the model to upstream inflows. Mill Falls is located within the centre of the catchment and a temporary gauge site both upstream and downstream of this structure would be desirable.

4.11.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Collooney model topographic survey data is within the Western CFRAM Survey Contract 2, work package 1. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-14: Collooney model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.12 Coolaney Model

4.12.1 Hydraulic modelling assessment

Coolaney will be modelled as a single fluvial hydraulic model using ISIS-TUFLOW. The watercourses to be modelled are shown in Figure 4-9. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-10.

Figure 4-9: Coolaney modelling overview map

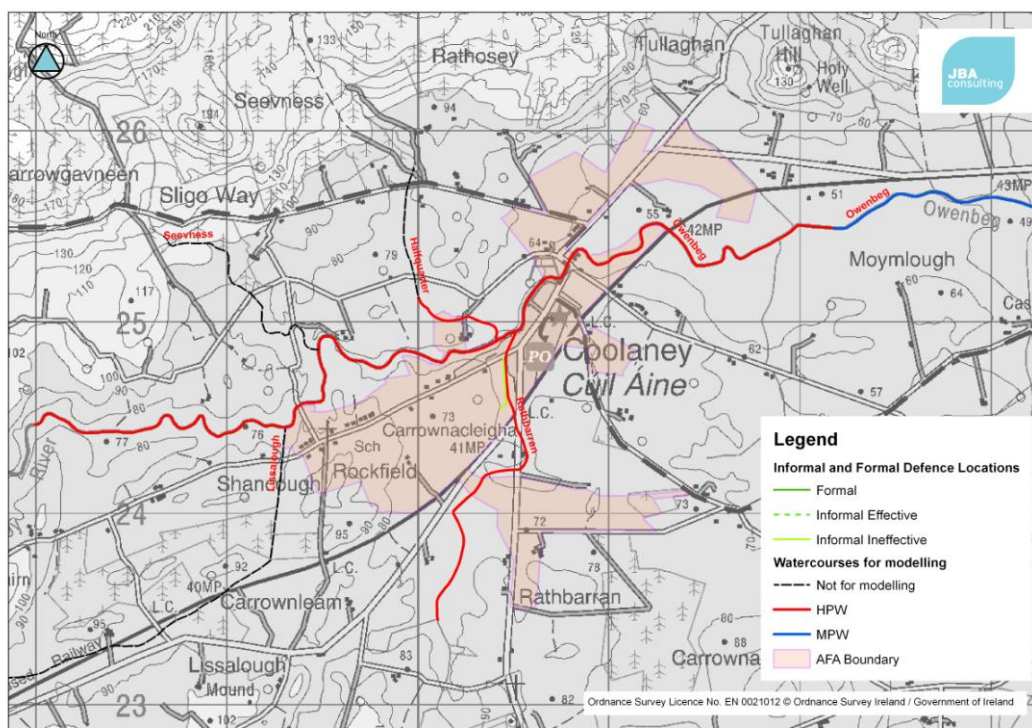


Figure 4-10: Coolaney modelling details map - at rear of report

Table 4-15 and Table 4-16 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-15: Coolaney model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|---|
| (a1) Number and length of watercourses within each hydraulic model | Owenbeg 5.7km Rathbarren 1.8km Halfquarter 1.8km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Moderate, perhaps high if rating extension goes well. |
| (a3) Detail the available records and operation of the closest gauge site (s). | A flow and level gauge exists at Billa Bridge downstream of the AFA. Records are available from 1971 to Present. |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | Some descriptions of flood risk within the area associated with the August 1986 flood are available. |
| (a5) Describe the boundary conditions and the data required. | The upstream limit of the model has been selected based on local topography to minimise the width of the flood plain. The downstream boundary will be a normal depth boundary. |
| (a6) Number and type of hydraulic structures present within the | 8 Bridges and 1 Weir. |

| | |
|---|--|
| model? | |
| (a7) What are the key hydraulic controls at the site? | <p>The key hydraulic control on the Owenbeg is the Coolaney Road Bridge, although the effect of this is expected to be limited.</p> <p>On the Rathbarren are a number of small structures that are expected to be locally important.</p> |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | The small structures on the Rathbarren are prone to blockage. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | Overtopping of the right bank on the Rathbarren could result in secondary flow routes, a 2-D model is therefore recommended. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | There are no defences within the AFA. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | N/A |
| (b3) Is a wave overtopping analysis likely to be required? | N/A |
| (b4) Is a joint probability analysis likely to be required? | N/A |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally located on the Rathbarren watercourse. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | No known development pressures. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The AFA is located upstream of the Collooney and Ballysadare AFAs. Therefore some consideration of strategic impacts will be required. |

Table 4-16: Coolaney model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|--|---|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 3 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 5 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 5 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 4 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 4 |
| Total Score | | | | | | 21 |
| <p>Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results</p> <p>Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances.</p> <p>Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal.</p> | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 3 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 4 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 4 |
| Total Score | | | | | | 11 |
| <p>Scores 3 to 7 – The site conditions suggest a flood management scheme is viable.</p> <p>Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan.</p> <p>Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited.</p> | | | | | | |
| AFA model output Ranking | D: Low confidence in model output and likely low scheme viability would suggest that this AFA will need further investigation and/or better local data on past flood events to be collected. A programme of monitoring may be recommended. | | | | | |

Flooding on the Rathbarren tributary is considered to be an important element of the flood risk assessment within this AFA. There is currently very limited data available with which to calibrate the hydraulic model within the AFA and particularly on this tributary. Confidence in the model results is likely to be low without additional gauge data. This will need to include a local subdaily recording raingauge and a staff gauge located on the Rathbarren tributary as a minimum.

4.12.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Coolaney model topographic survey data is within the National Survey Contract 6, work package 7. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-17: Coolaney model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.13 Gorteen Model

4.13.1 Hydraulic modelling assessment

Gorteen will be modelled as a single fluvial hydraulic model using ISIS-TUFLOW. The watercourses to be modelled are shown in Figure 4-11. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-12.

Figure 4-11: Gorteen modelling overview map

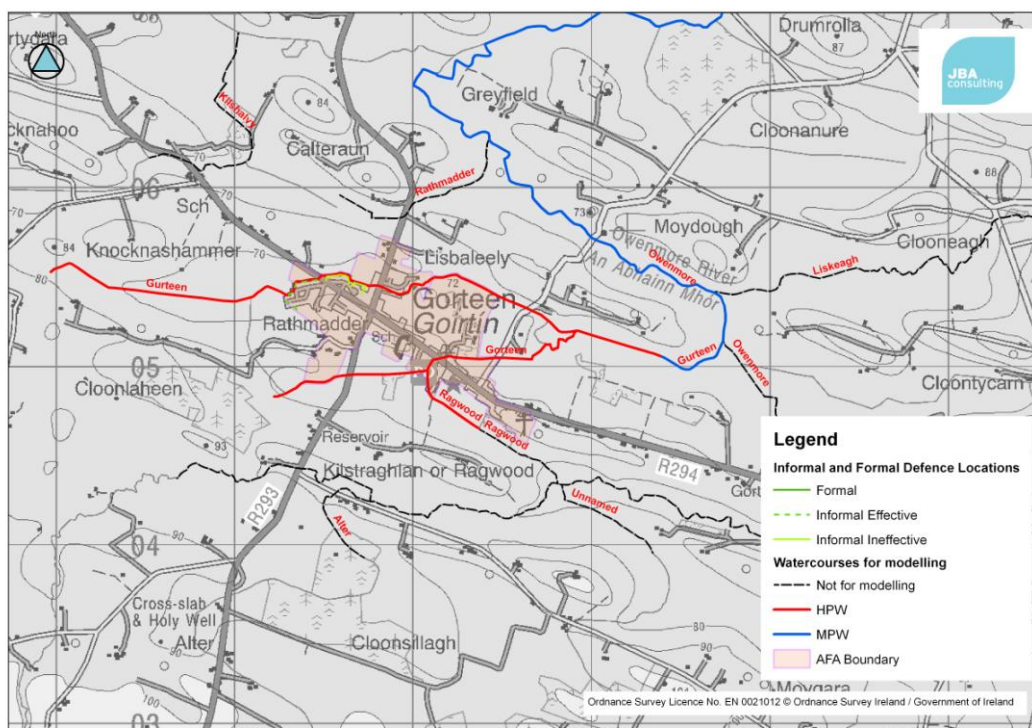


Figure 4-12: Gorteen modelling details map - at rear of report

Table 4-18 and Table 4-19 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-18: Gorteen model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|---|
| (a1) Number and length of watercourses within each hydraulic model | Gurteen 3.8km Gorteen 1.9km Ragwood 0.5km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Very Low. |
| (a3) Detail the available records and operation of the closest gauge site (s). | <p>The nearest recording gauge is Big Bridge located on the Owenmore River downstream of the site. Big Bridge is a flow and level gauge for which records are available between 1956 and 1969.</p> <p>The Lisbaleely staff gauge is located on Gurteen Stream upstream of Greyfield Road. Records are available between 1980 and 1997.</p> <p>The Moydough staff gauge is located downstream of the AFA on the Owenmore. Records are available between 1990 and 1996.</p> |
| (a4) Detail the available historical | There calibration data at the site is limited to the staff gauge |

| | |
|---|---|
| data for model calibration and state any limitations associated with this data. | data described above. |
| (a5) Describe the boundary conditions and the data required. | The upstream limit of the model has been selected based on local topography to minimise the width of the flood plain. The downstream boundary will be a normal depth boundary. |
| (a6) Number and type of hydraulic structures present within the model? | 6 Bridges and 1 Culvert. |
| (a7) What are the key hydraulic controls at the site? | The watercourses within the AFA are relatively small and the multiple small structures along each of these are likely to be of hydraulic importance in the local vicinity. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | The size of the majority of structures suggests they may be prone to blockage and sensitive to assumptions. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is within the town of Gorteen and is likely to contain properties. Overland flow paths as a result of culvert blockage may also need to be investigated. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | Walls on the right bank of the Gurteen as detailed in Section 2.6 may provide informal effective flood mitigation. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No. |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | N/A |
| (b3) Is a wave overtopping analysis likely to be required? | N/A |
| (b4) Is a joint probability analysis likely to be required? | N/A |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally distributed across multiple locations within Gorteen. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | Some of the floodplain on the left bank of the Gurteen has been zoned for residential development. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The AFA is located a significant distance upstream of the Ballysadare AFA and strategic impacts are expected to be minimal. |

Table 4-19: Gorteen model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|--|---|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 4 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 4 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 4 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 4 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 4 |
| Total Score | | | | | | 20 |
| <i>Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results</i> <i>Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances.</i> <i>Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal.</i> | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 2 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 3 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 3 |
| Total Score | | | | | | 8 |
| <i>Scores 3 to 7 – The site conditions suggest a flood management scheme is viable.</i> <i>Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan.</i> <i>Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited.</i> | | | | | | |
| AFA model output Ranking | D: Low confidence in model output and likely low scheme viability would suggest that this AFA will need further investigation and/or better local data on past flood events to be collected. A programme of monitoring may be recommended. | | | | | |

There is limited historical evidence of flooding to the site. The Lisabeely staff gauge provides the only usable data for calibration. The data provided incorporates a series of spot gaugings only and calibration will therefore be limited to a possible verification of the rating curve in the model at this location. To allow detailed model calibration it will be necessary to install a subdaily recording raingauge in conjunction with a recording level gauge to provide sufficient data.

4.13.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Gorteen model topographic survey data is within the National Survey Contract 6, work package 7. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-20: Gorteen model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.14 Manorhamilton Model

4.14.1 Hydraulic modelling assessment

Manorhamilton will be modelled as a single fluvial hydraulic model using ISIS-TUFLOW. The watercourses to be modelled are shown in Figure 4-13. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-14.

Figure 4-13: Manorhamilton modelling overview map

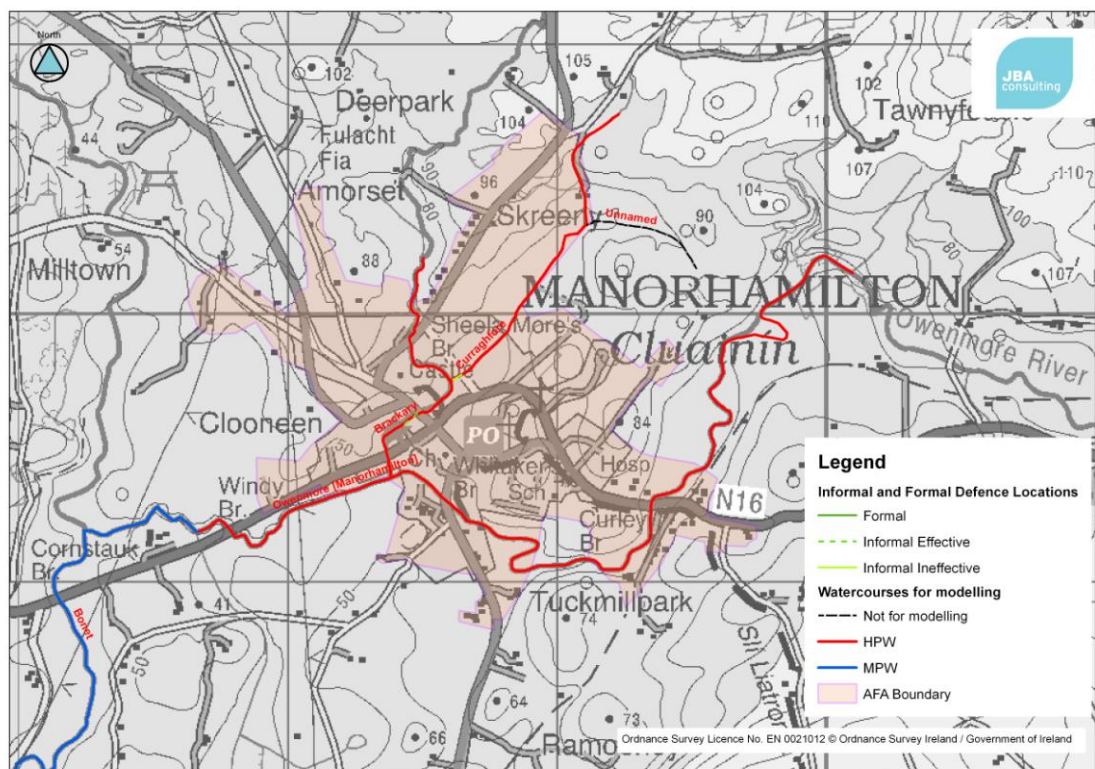


Figure 4-14: Manorhamilton modelling details map - at rear of report

Table 4-21 and Table 4-22 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-21: Manorhamilton model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|--|
| (a1) Number and length of watercourses within each hydraulic model | Curraghfore 1.3km Owenmore 4.1km Brackary 1.1km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Low |
| (a3) Detail the available records and operation of the closest gauge site (s). | <p>The two nearest recording gauges are New Bridge (Manorhamilton) and Dromahair located on the Bonet River upstream and downstream of the Owenmore tributary respectively.</p> <p>New Bridge is a flow and level gauge for which records are available between 1990 and Present. Dromahair is a flow and level gauge for which records are available between 1957 to Present.</p> <p>The Curley Bridge and Windy Bridge staff gauges are located on the Owenmore Stream within the AFA. Records are</p> |

| | |
|---|---|
| | available between 2003 and 2006 for the Curley Bridge and between 1983 and 2008 for the Windy Bridge gauge. |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | There calibration data at the site is limited to the staff gauge data described above. |
| (a5) Describe the boundary conditions and the data required. | The upstream limit of the model has been selected based on local topography to minimise the width of the flood plain. The downstream boundary will be a normal depth boundary. |
| (a6) Number and type of hydraulic structures present within the model? | 11 Bridges, 1 Culvert and 2 Weirs. |
| (a7) What are the key hydraulic controls at the site? | The majority of the structures in the site are well sized and there are no outstanding hydraulic controls. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | As above. |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is expected to be narrow around the channel. Flow velocities however are a critical issue along this watercourse and any out of bank flows will need to be assessed within a 2-D model for confidence. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | A single defence exists on the left bank of the Brackery River as detailed in Section 2.6, it is not expected this will require a breach analysis. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No. |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | N/A |
| (b3) Is a wave overtopping analysis likely to be required? | N/A |
| (b4) Is a joint probability analysis likely to be required? | N/A |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally located at local sites along the length of the AFA. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | No known major development pressures at the site. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The AFA is located a significant distance upstream of the Sligo AFA and there are no known strategic impacts to consider. |

Table 4-22: Manorhamilton model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|---|--|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 4 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 4 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 3 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 1 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 2 |
| Total Score | | | | | | 14 |
| Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances. Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal. | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 2 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 5 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 3 |
| Total Score | | | | | | 10 |
| Scores 3 to 7 – The site conditions suggest a flood management scheme is viable. Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan. Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited. | | | | | | |
| AFA model output Ranking | C: Low scheme viability (based on flood risk impacts and scale of management options) with good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term. | | | | | |

The Curly Bridge and Windy Bridge staff gauges provide usable data for calibration within the central reach of the AFA. The data provided incorporates a series of spot gaugings only and calibration will therefore be limited to a possible verification of the rating curve in the model at these locations.

To allow detailed model calibration it will be necessary to install a subdaily recording raingauge in conjunction with a recording level gauge on each of the two main watercourses to provide sufficient data.

4.14.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Manorhamilton model topographic survey data is within the Western CFRAM Survey Contract 2, work package 1. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-23: Manorhamilton model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.15 Riverstown Model

4.15.1 Hydraulic modelling assessment

Riverstown will be modelled as a single fluvial hydraulic model using ISIS-TUFLOW. The watercourses to be modelled are shown in Figure 4-15. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-16.

Figure 4-15: Riverstown modelling overview map

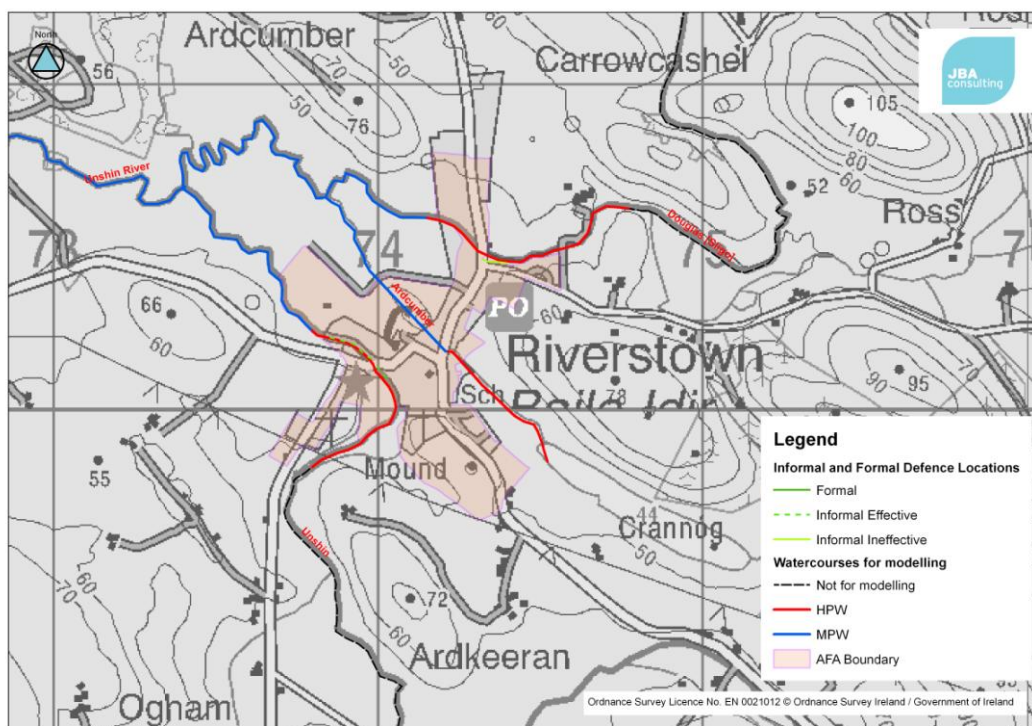


Figure 4-16: Riverstown modelling details map - at rear of report

Table 4-24 and Table 4-25 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-24: Riverstown model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|---|
| (a1) Number and length of watercourses within each hydraulic model | Ardumber 0.5km Douglas 0.7km Unshin 0.7km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Moderately low, perhaps moderately high if rating development goes well. |
| (a3) Detail the available records and operation of the closest gauge site (s). | There are no recording gauges in the immediate vicinity of Riverstown. The Riverstown staff gauge is located on the Unshin River. Records are available between 1979 and 2008. |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | Some key areas of flood risk have been highlighted in discussions with the Council. Outside of this calibration data is limited to the staff gauge discussed above. |
| (a5) Describe the boundary conditions and the data required. | The upstream limit of the model has been selected based on local topography to minimise the width of the flood plain. |

| | |
|---|--|
| | The downstream boundary will be a normal depth boundary. |
| (a6) Number and type of hydraulic structures present within the model? | 3 Bridges and 1 Culvert. |
| (a7) What are the key hydraulic controls at the site? | The key hydraulic control on each watercourse is Cooperhill Road Bridge on the Unshin River, Ardculmer Road Bridge on the Douglas River and a long culvert on the Ardculmer watercourse. |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | <p>The Cooperhill and Ardculmer Road Bridge are multi arch bridges and debris build up has been reported.</p> <p>The hydraulics of the long culvert could be sensitive to modelling parameters.</p> |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | <p>Out of bank flow is expected to be relatively simple on the Unshin and Douglas Rivers.</p> <p>Overtopping flows from the Ardculmer would flow through town and would need to be represented in 2-D.</p> |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | A wall on the right bank of the Unshin, Section 2.6, is considered to be providing a flood defence function. |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | No. |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | N/A |
| (b3) Is a wave overtopping analysis likely to be required? | N/A |
| (b4) Is a joint probability analysis likely to be required? | N/A |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is spread across the three watercourses. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | No known development pressures. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The AFA is located a significant distance upstream of the Ballysadare AFA and strategic impacts are expected to be minimal. |

Table 4-25: Riverstown model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|--|---|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 4 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 4 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 4 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 3 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 3 |
| Total Score | | | | | | 18 |
| <p>Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results</p> <p>Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances.</p> <p>Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal.</p> | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 2 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 5 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 1 |
| Total Score | | | | | | 8 |
| <p>Scores 3 to 7 – The site conditions suggest a flood management scheme is viable.</p> <p>Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan.</p> <p>Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited.</p> | | | | | | |
| AFA model output Ranking | D: Low confidence in model output and likely low scheme viability would suggest that this AFA will need further investigation and/or better local data on past flood events to be collected. A programme of monitoring may be recommended. | | | | | |

The Riverstown staff gauge provides usable data for calibration within the AFA. The data provided incorporates a series of spot gaugings only and calibration will therefore be limited to a possible verification of the rating curve in the model at these locations.

To allow detailed model calibration it will be necessary to install a recording level gauge on each of the two main watercourses to provide sufficient data. Due to the size of these watercourses and hence the duration of storm events it may be feasible to use existing rain gauges located in the upstream catchments for the purposes of calibration.

4.15.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Riverstown model topographic survey data is within the National Survey Contract 6, work package 7. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-26: Riverstown model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.16 Sligo Model

4.16.1 Hydraulic modelling assessment

Sligo will be modelled as four separate fluvial hydraulic model using ISIS-TUFLOW as a minimum. The site also includes a gauge site on the Garvoge River; the developed model will be used to review the rating at the gauge site. The watercourses to be modelled are shown in Figure 4-17. A more detailed map of the AFA with additional details is included at the rear of the report Figure 4-18.

Figure 4-17: Sligo modelling overview map

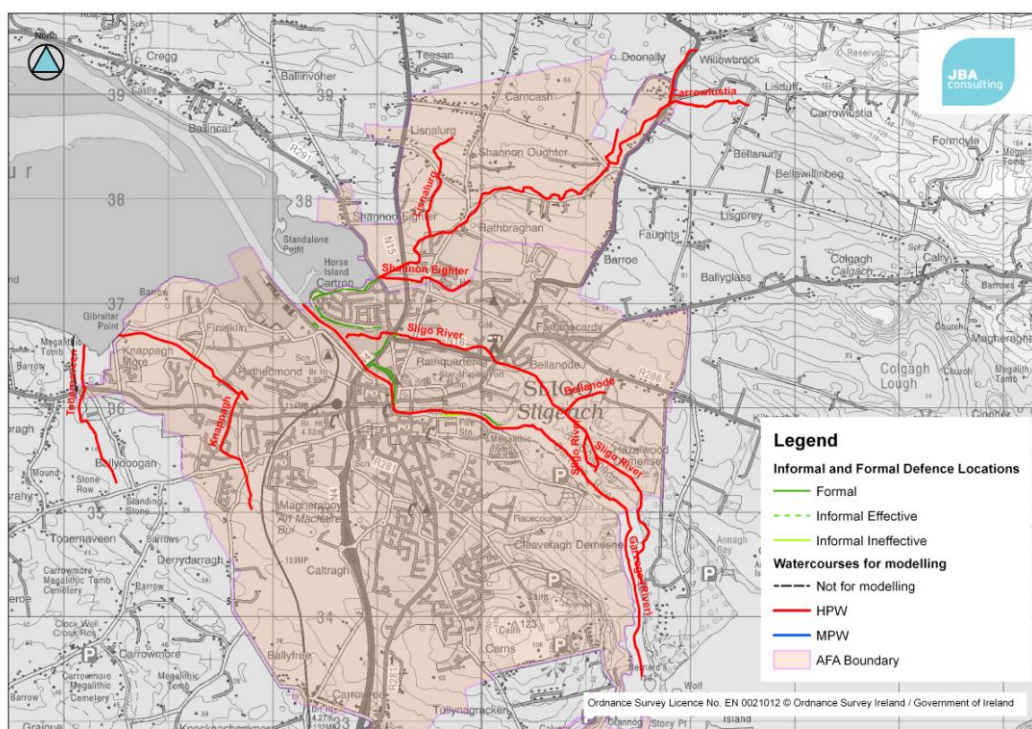


Figure 4-18: Sligo modelling details map - at rear of report

Table 4-27 and Table 4-28 summarise the model requirements, expected confidence in the model results and the likely requirements of the model in determining a scheme in the latter stages of the project.

Table 4-27: Sligo model assessment of model requirements

| A - General Modelling Key Considerations | |
|--|--|
| (a1) Number and length of watercourses within each hydraulic model | Garvoge River 5.7km Sligo River 5.1km Tobernaveen 1.5km Bellanode 0.5km Knappagh 2.7km Willsborough Stream 4.5km Shannon Eighter 1.0km Lisnalgur 1.1km Shannon Oughter 0.4km Carrowlustia 0.8km |
| (a2) What is the expected confidence in the hydrology? (see Table 3-2) | Moderately high but decreasing for low AEPs due to unusual catchment (lake influence) |
| (a3) Detail the available records and operation of the closest gauge site (s). | Two gauges exist within the AFA, both with flow and level data available. |

| | |
|---|---|
| | <p>L Gill at the outfall of Lough Gill into the Garvoge River and has records from 1975 to Present.</p> <p>New Bridge is located on the Garvoge River a short distance upstream of New Bridge in the town centre and has records from 2001 to Present only.</p> |
| (a4) Detail the available historical data for model calibration and state any limitations associated with this data. | <p>There is a limited period when both gauges were in operation between 2001 and 2004. The majority of large events at the L Gill gauge occurred prior to this period. The presence of the two gauges provides an opportunity to calibrate the upstream reaches of the model in low order events.</p> <p>There are no historical records of flooding associated with a given event with which to calibrate the model, although the lack of historical flooding itself provides a broad calibration. New Bridge is reported to control flows in large events suggesting some uncertainty associated with flows and levels downstream of this structure.</p> <p>The majority of flood risk is reported along the lower reaches of the Garvoge and is associated with tidal flooding. Flooding at Fish Street and in the vicinity of Lower Quay Street is reported in extreme tides. Flooding could occur around 2.7mAOD Malin in Lower Quay Street.</p> <p>There is no data on the Sligo River.</p> |
| (a5) Describe the boundary conditions and the data required. | <p>The location of the gauge at the upstream limit of the model should dictate the design flows for the model.</p> <p>The Sligo River will be connected into the Garvoge River at its upstream limits with discharges into this watercourse dictated by the topography upstream of Sligo Town.</p> <p>The downstream boundary will be a still water tidal profile.</p> |
| (a6) Number and type of hydraulic structures present within the model? | 8 Bridges, 1 Culvert and 2 Weirs. |
| (a7) What are the key hydraulic controls at the site? | <p>The key hydraulic control is the John Fallon weir at low flows. At higher flows it is reported the weir becomes drowned out and the New Bridge controls downstream flows.</p> <p>Hyde Bridge at the downstream of the site is a relatively complex structure with weirs on the upstream and downstream face and a fish pass on the right bank.</p> |
| (a8) Are any of the hydraulic control structures expected to be sensitive to modelling assumptions or flows? | <p>Both Hyde Bridge and New Bridge are multiple arch bridges which are liable to blockage.</p> <p>The N4 Road Bridge on the Sligo River has also blocked historically so some sensitivity at this structure is expected.</p> |
| (a9) Describe any complexities in the floodplain. Could the floodplain be represented using a 1-D model? | The floodplain is expected to be narrow around the channel, however in extreme events there is a large amount of complexity immediately adjacent to the channel. A 1-D model is not appropriate in this instance. |
| (a10) Are there defence assets that will require breach analysis? Detail the flood source, length and site description. | <p>A tidal defence is located on the right bank of the Garvoge upstream of the N4. This is approximately 500m in length.</p> <p>A fluvial defence is located on the left bank of the Sligo River upstream of the N4. This is approximately 100m in length.</p> <p>Further details are provided in Section 2.6.</p> |
| B - Coastal Modelling Key Considerations | |
| (b1) Is there coastal flood risk associated with site? | Yes, historically coastal flooding of Lower Quay Street and Fish Street has occurred. |
| (b2) Based on the topography of the site is a coastal model required or can tidal levels be extrapolated inland? | <p>Flood risk within the town is via the Garvoge River and this will be represented in the fluvial model.</p> <p>There is an industrial area on the left bank of the outer estuary</p> |

| | |
|---|---|
| | downstream of the N4. A large section of this site is within 1m of the extreme sea level and as such coastal model of this industrial area will be required. |
| (b3) Is a wave overtopping analysis likely to be required? | The industrial area is susceptible to wave action from within the harbour and from across the bay. Wave overtopping will be required as part of the coastal modelling. |
| (b4) Is a joint probability analysis likely to be required? | The delineation between the tidal and fluvial flood risk is thought to be relatively abrupt and located at the two weirs adjacent to Hyde Bridge. It is not expected a joint probability analysis will be required. |
| C - Flood Risk Assessment Key Elements | |
| (c1) Is flood risk concentrated in a single location or distributed across the AFA? | Flood risk is generally located at local sites within the tidal reaches of both watercourses. |
| (c2) Are there any development pressures within the AFA boundary where flood risk will need to be considered? | No known development pressures. |
| (c3) Are there upstream/downstream strategic considerations for any potential scheme within/outside the site? | The majority of flood risk is tidal and therefore there are limited expected impacts outside of the immediate vicinity of any scheme. |

Table 4-28: Sligo model provisional assessment of deliverables

| Confidence in Achievable Model Results given the available data | | | | | | |
|---|--|-----------|--|----------|---|---------|
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Hydrology (a2) | High confidence | | Moderate confidence | | Low confidence | 2 |
| Calibration Data (a3/a4) | Knowledge at each key structure. | | Knowledge at multiple points in system | | None | 3 |
| Locality of Calibration Data (a4/c1/c2) | Immediately adjacent to all areas of interest | | Can be confidently extrapolated to multiple but not all areas of interest | | Cannot be confidently extrapolated to any areas of interest. | 3 |
| Sensitivity of Structures (a7/a8) | No significant hydraulic influence. | | Evidence of response in a flood event. | | High uncertainty associated with blockage or structure capacity. No evidence of response in a flood event. | 4 |
| Floodplain Complexity (a9) | Open floodplain | | Structures are located at the edge of the floodplain | | Heavily urbanised with complex flow routes. | 3 |
| Total Score | | | | | | 15 |
| Scores 5 to 12 – The site is sufficiently well understood and has appropriate data to deliver a model with good confidence in results Scores 13 to 17 - The site is sufficiently well understood but has some uncertainties. There is enough data to deliver a model that is fit for purpose but will require appropriate uncertainty allowances. Scores 18 to 25 - The site is likely to be poorly understood and there is insufficient data to deliver good confidence in model results. Additional data collection may be required before options appraisal. | | | | | | |
| Expected Scheme Viability | | | | | | |
| | Score | | | | | |
| | 1 | 2 | 3 | 4 | 5 | For AFA |
| Majority of Flood Risk Receptors | Social | | Economic | | Environment | 3 |
| No of Properties Affected in the 100 yr Event | >100 | 50 to 100 | 25 to 50 | 10 to 25 | 0 | 4 |
| Likely Scale of Management Options | Quick Win – Schemes focus on a single source/pathway and can be managed as discrete units | | Options Appraisal – Multiple flood risk receptor sites require integrated assessment within the AFA boundary only. | | Complex Options Appraisal – Schemes are non simple and require strategic considerations across multiple AFAs boundary | 2 |
| Total Score | | | | | | 9 |
| Scores 3 to 7 – The site conditions suggest a flood management scheme is viable. Scores 8 to 10 – The site conditions suggest a flood management scheme is possible but additional funding/complexity is associated with any management plan. Scores 11 to 15 – The site conditions suggest the viability of a flood management scheme is limited. | | | | | | |
| AFA model output Ranking | C: Low scheme viability (based on flood risk impacts and scale of management options) with good certainty in model output. Additional funding/justification likely to be required before scheme works can be progressed in the long term. | | | | | |

The AFA consists of a series of independent watercourses draining to the sea. Two gauges exist on the Garvoge watercourse and good confidence can be expected in model results from this watercourse. The Lough Gill gauge is also expected to be applicable to some extent on the Sligo River as the headwaters of this watercourse collect overflow from the Garvoge.

The two gauges are not applicable to the remaining watercourses within the AFA. There is no calibration for these and confidence in model results is expected to be low. To allow detailed model calibration it will be necessary to install a subdaily recording raingauge within the AFA in conjunction with a recording level gauge on each of the main watercourses to provide sufficient

data. These should include Willsborough Stream, the Shannon Eighter and the Knappagh watercourses as a minimum.

4.16.2 Programme

The main constraints on beginning the hydraulic modelling are the delivery of topographic survey and the delivery of LIDAR aerial survey. The Sligo model topographic survey data is within the Western CFRAM Survey Contract 1, work package 3. The Rathbragan area topographic survey on the north side of the Sligo AFA is within the National CFRAM Survey Contract 6, work package 7. For the final models and maps an additional constraint is the delivery of design flow hydrology.

The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-29: Sligo model programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.17 Hydraulic modelling of Medium Priority Watercourses (MPW)

MPWs are defined as reaches of a watercourse:

- providing hydraulic connectivity between two reaches of HPW on a watercourse within a unit of management,
- downstream of each HPW until it discharges into open sea, or
- downstream of MPW upstream limits until they discharge into open sea excluding those already defined as HPW.

Within UoM35 there are four MPWs extending downstream from Gorteen, Coolaney, Riverstown and Manorhamilton. Ballymote has a short MPW reach which then links into the MPW from Gorteen. The hydraulic modelling of these is discussed below.

The remaining three AFAs have no associated MPW. Sligo and Ballysadare are on the coast so have no associated MPW. Collooney is a short distance upstream of Ballysadare and the floodplain in this location has made it preferable to model the intervening reach as HPW.

MPWs will be modelled as sparse hydraulic models using ISIS. Cross sections will be widely spaced (typically 500m) but structures will be included. Floodplains will be modelled using extended cross sections, the floodplain part of which will come from the best available DTM. In many areas it is expected that the DTM may be lower quality than LIDAR, with a target RMSE accuracy of the vertical component of 0.5m. It is possible the accuracy of this DTM could cause problems in model construction and/or flood mapping, e.g. inconsistency with surveyed data.

4.17.1 Gorteen to Collooney including Ballymote Stream Tributary

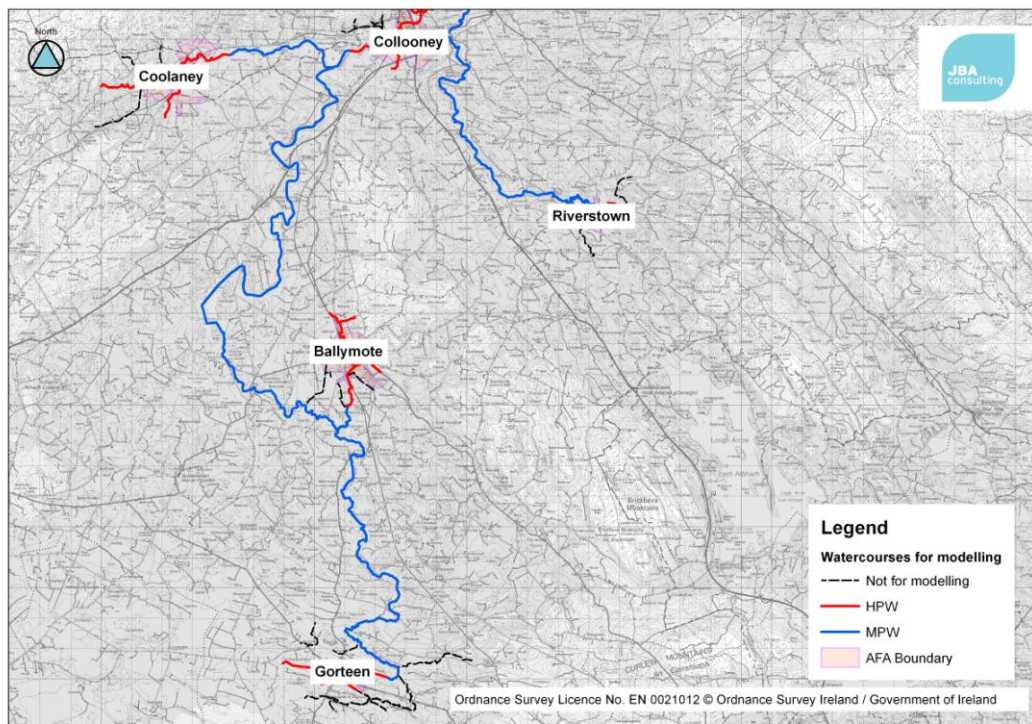
The MPW of the Owenmore River from Gorteen to Collooney is shown in Figure 4-19 and is approximately 41km. The Ballymote Stream tributary is approximately 1km.

A single ISIS model will be constructed of this reach with sparse cross section spacing. The ISIS model will use extended cross sections to model floodplain flows. This will rely on using low quality terrain data for floodplain representation for the majority of its length which could compromise the accuracy of the flood modelling and mapping.

It appears LIDAR will be available for this MPW downstream of the confluence with the Owenbeg River which will help with the representation of floodplain flow within the model and mapping of flood extents.

At major confluences an inflow unit will be used to represent the incoming watercourse. A suitable downstream boundary will be developed from the Collooney HPW model.

Figure 4-19: Gorteen to Collooney MPW



The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-30: Gorteen to Collooney MPW programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

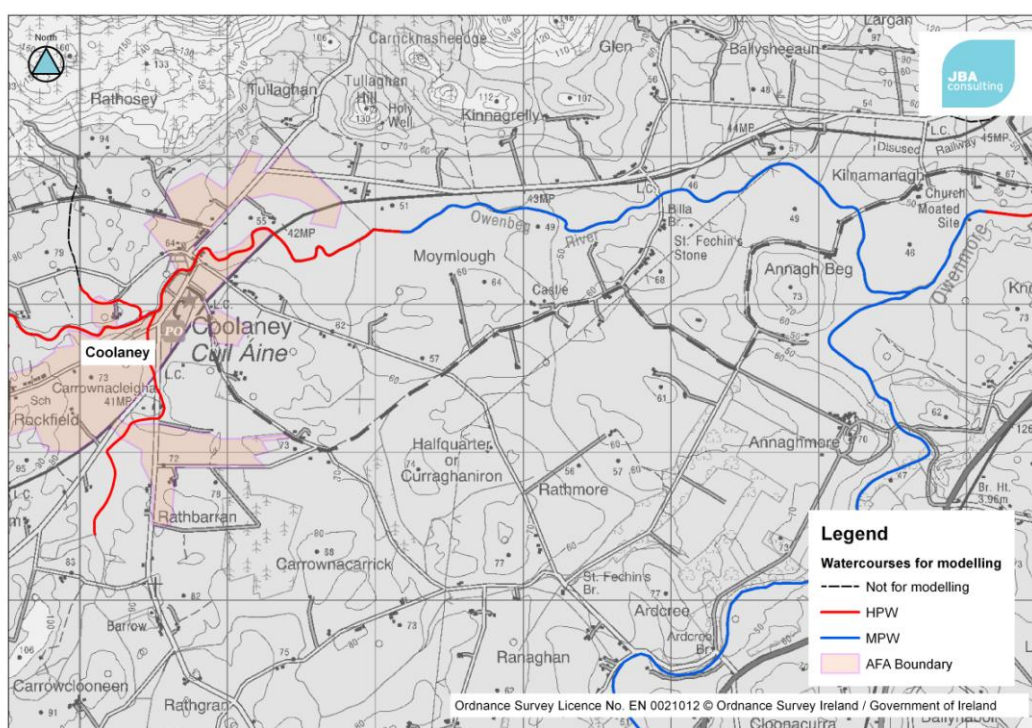
4.17.2 Coolaney to Owenbeg/Owenmore River Confluence

The Owenbeg River to its confluence with the Owenmore River is shown in Figure 4-20 and is approximately 12km. An ISIS model will be constructed of this reach with sparse cross section spacing. The ISIS model will use extended cross sections to model floodplain flows.

It appears LIDAR will be available for this MPW which will help with the representation of floodplain flow within the model and mapping of flood extents. At major confluences an inflow unit will be used to represent the incoming watercourse. A suitable downstream boundary will be developed from the Gorteen to Collooney MPW model.

It may be deemed preferable during the development of this model to join it to the Gorteen to Collooney MPW model to facilitate the representation of the floodplain at the Owenbeg/Owenmore River confluence.

Figure 4-20: Coolaney to Owenbeg/Owenmore River confluence MPW model



The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

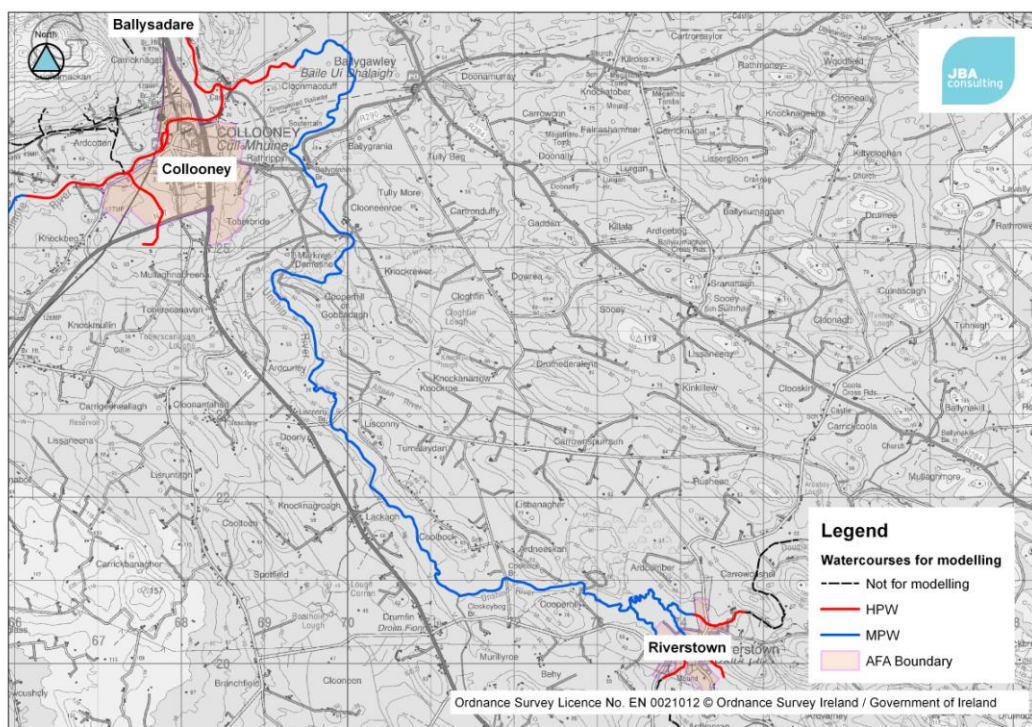
Table 4-31: Coolaney to Owenbeg/Owenmore River confluence MPW programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.17.3 Riverstown to Collooney

The MPW downstream of Riverstown to Collooney Gill is shown in Figure 4-21 and is approximately 16km. A single ISIS model will be constructed of this reach with sparse cross section spacing. The ISIS model will use extended cross sections to model floodplain flows. This will rely on using low quality terrain data for floodplain representation for the majority of its length which could compromise the accuracy of the flood modelling and mapping.

Figure 4-21: Riverstown to Collooney MPW



The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

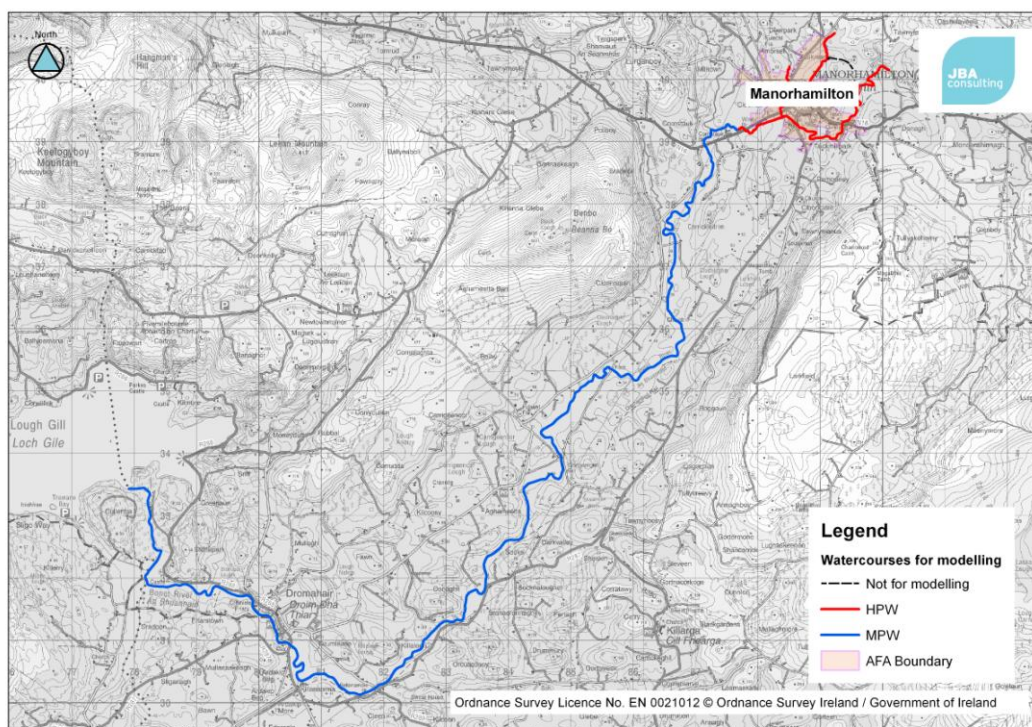
Table 4-32: Riverstown to Collooney MPW programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.17.4 Manorhamilton to Lough Gill

The MPW downstream of Manorhamilton to Lough Gill is shown in Figure 4-22 and is approximately 22km. A single ISIS model will be constructed of this reach with sparse cross section spacing. The ISIS model will use extended cross sections to model floodplain flows. This will rely on using low quality terrain data for floodplain representation for the majority of its length which could compromise the accuracy of the flood modelling and mapping.

Figure 4-22: Manorhamilton to Lough Gill MPW



The programme constraints have been included in the master programme and key dates will be provided in this report when the programme has been approved by OPW.

Table 4-33: Manorhamilton to Lough Gill MPW programme dates

| Date | Task |
|------|--|
| | Survey Availability |
| | Assumed LIDAR Availability |
| | Design Flow Availability |
| | Start of Model Build |
| | Complete Model Build |
| | Complete Flood Hazard Mapping |
| | Delivery of UoM 35 Draft Hydraulics Report |

4.18 Flood Hazard Mapping

In the AFAs modelled in 2D models (expected to be all AFAs in UoM 35) depth, level and velocity grids will be available for each return period as part of standard model output.

Hazard will be calculated using the Defra FD2321⁵ formula as used in the CFRAM pilots. We will use the facility in TUFLOW to calculate flood hazard as part of the model outputs. The Flood Hazard rating is calculated using the following equation:

$$HR = d \times (v + 0.5) + DF$$

- where, HR = (flood) hazard rating;
- d = depth of flooding (m);
- v = velocity of floodwaters (m/sec); and
- DF = calculated debris factor

The CFRAM specification is very clear on flood hazard mapping requirements and this will be followed for each AFA (Table 4-34). The UMap tool for confidence in flood outlines has already been used by JBA and we expect to use this again for the CFRAM outputs. Flood Hazard Maps will be produced at the end of the modelling work in each AFA.

Table 4-34: Flood mapping requirements - flood event probabilities to be mapped for each scenario

| Type of Flood Map | Current | MRFS | HEFS |
|-------------------------------------|-------------------|-------------------|---------------|
| Flood Extent – GIS | All Probabilities | All Probabilities | 10%, 1%, 0.1% |
| Flood Extent – Print-Ready | 10%, 1%, 0.1% | 10%, 1%, 0.1% | Not Required |
| Flood Zone – GIS | 1%, 0.1% | 1%, 0.1% | Not Required |
| Flood Zone – Print-Ready | 1%, 0.1% | Not Required | Not Required |
| Flood Depth – GIS | All Probabilities | 10%, 1%, 0.1% | Not Required |
| Flood Depth – Print-Ready | 10%, 1%, 0.1% | Not Required | Not Required |
| Flood Velocity – GIS | All Probabilities | Not Required | Not Required |
| Flood Velocity – Print-Ready | 10%, 1%, 0.1% | Not Required | Not Required |
| Flood Hazard Function – GIS | 10%, 1%, 0.1% | Not Required | Not Required |
| Flood Hazard Function – Print-Ready | 10%, 1%, 0.1% | Not Required | Not Required |

Note - for tidal flooding 0.5% AEP replaces 1% AEP when range is restricted.

4.19 Hydraulics Report

The outcome from the modelling and mapping stages is the hydraulics report. This report will be issued for the UoM, rather than individual AFAs. The proposed structure of the report is given below which will be reproduced for each AFA.

1. Introduction – statement of model objectives and project outcomes, geographical location, type and extent of the models (include a map)
2. Qualitative/conceptual description/understanding of the real world system
3. Hydraulic model approach and justification of how this approach is appropriate to risk. Indicate any perceived advantages or disadvantages of applying the chosen modelling approach. Include a clear method statement, which shows how the modelling was carried out to fulfil the objectives. To include approach/basis for model proving, i.e. how it was validated (to establish confidence in the model/outputs).
4. Model Input Data - including data quality and appropriateness for intended use and highlight possible uncertainty

⁵ Defra / Environment Agency Flood and Coastal Defence R&D Programme, R&D OUTPUTS: FLOOD RISKS TO PEOPLE Phase 2, FD2321/TR2, Guidance Document, March 2006
2011s5232 WCFRAM UoM35 Final Inception Report v3.0.doc

5. Model build process – including calibration, verification and sensitivity testing
6. Scenarios – details data need/requirements for any scenarios that have been run, e.g. without defences and varying annual probability events
7. Model Output Data – including flows, level, maps, reports and specific products
8. Model findings / knowledge gained of system (e.g. hydraulic controls, dominant processes) including description of any constraints on the data that would prevent the onward transmission of the output data to third parties on its publication in other reports

In addition to the report, the following data will also be supplied:

- Survey data
- Digital model files
- Defence asset database
- Flood Hazard Maps

4.20 Flood risk assessment

The Flood Risk Assessment stage using the modelled results to assess and map the potential adverse consequences (risk) associated with flooding to four risk receptor groups, namely:

- Society (including risk to people),
- The Environment,
- Cultural Heritage,
- The Economy,

Our proposed mapping to address this requirement is given in Table 4-35.

Table 4-35: Proposed flood risk assessment mapping

| | Arcmap number | Title | No. of Maps | Description |
|---------------------------|---------------|--|---|--|
| Social Risk | S1 | Location and Number of Residential Properties | Dataset changes with each flood extent (10%, 1% and 0.1% for existing and MRFS) | Point data set of all residential properties and Grid Squares of Counts of residential properties |
| | S2 | High Vulnerability Sites | Fixed dataset overlain on different outlines | Point data set of Schools, Care Homes, Nursing Homes and Health Centres detailing level of vulnerability of each. Vulnerability in this case is fixed per receptor type so could be shown in the legend. |
| | S3 | Valuable Social Infrastructure Assets | Fixed dataset overlain on different outlines | Point data set of Fire, Garda, Civil Defence, Hospitals and Government Buildings detailing level of vulnerability of each. Vulnerability in this case for Government Buildings is variable so method of showing of the map is required. |
| | S4 | Social Amenity Sites | Fixed dataset overlain on different outlines | Parks and leisure facilities - will use development zonal mapping where available |
| Risk to the Environment | E1 | Integrated Pollution Prevention Control Licenced Premises | Fixed dataset overlain on different outlines | Point dataset of IPPC licenced premises |
| | E2 | Water Framework Directive Annex IV Protected Areas | Fixed dataset overlain on different outlines | Areas designated for the abstraction of water intended for human consumption, bodies of water designated as recreational including bathing waters and areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites. |
| | E3 | Other environmentally valuable sites | Fixed dataset overlain on different outlines | Polygon dataset of NHAs, SACs and SPAs. Vulnerability is variable. |
| Risk to Cultural Heritage | H1 | Sites of Cultural Value | Fixed dataset overlain on different outlines | Point data sets of built heritage (niah buildings), museums and archaeological/historical monument sites (ignore UNESCO double sites file). Vulnerability is variable so method of showing on map is required. |
| Risk to the Economy | Ec1 | Location of residential and non-residential properties and number of non residential | Dataset changes with each flood extent (10%, 1% and 0.1% for existing and MRFS) | Point data set of residential and non residential properties and 100m grid square count of non residential properties. (Type and count of non res properties based on NACE codes to be provided in tabular form only. |

| | Arcmap number | Title | No. of Maps | Description |
|-------------------------------|---------------|--|---|---|
| | | properties | | |
| | Ec2 | Density of Economic Risk | Fixed dataset from existing risk or MRFS overlain on relevant outlines | Grid Squares of average annual damages. |
| | Ec3 | Transport Infrastructure | Dataset changes with each flood extent (10%, 1% and 0.1% for existing and MRFS) | Grid Squares showing lengths with locations overlaid of linear and point datasets of transport infrastructure including airport and ports point dataset and roads and rail linear infrastructure. Vulnerability may be fixed so could be shown on legend. |
| | Ec4 | Utility Infrastructure | Fixed dataset overlain on different outlines | Point datasets of electricity, water supply and treatment, gas and oil, telecom etc. Vulnerability is fixed so can be shown in legend. |
| Indicative No. of Inhabitants | Pop1 | Population Density - multiplier to be specified by OPW | Dataset changes with each flood extent (10%, 1% and 0.1% for existing and MRFS) | Grid Square of number of inhabitants at risk in the 10% AEP |
| Types of Economic Activity | EcAct1 | Economic Activity to be specified by OPW | Dataset changes with each flood extent (10%, 1% and 0.1% for existing and MRFS) | Map showing types of property use |

4.21 Hydraulic Analysis Summary for UoM 35

The proposed list of AFA priority and programme is shown in Table 4-36 for UoM 35.

Table 4-36: Proposed list of AFA priority and programme for UoM 35.

| AFA | Model Output Ranking | Rating Review in AFA? | Model Type | Proposed AFA Modelling Start Date | Proposed AFA Modelling Completion Date |
|--------------------------------|----------------------|-----------------------|---------------|-----------------------------------|--|
| Ballymote | D | No | 1D-2D Fluvial | | |
| Ballysadare | C | Yes | 1D-2D Fluvial | | |
| Collooney | C | No | 1D-2D Fluvial | | |
| Coolaney | D | No | 1D-2D Fluvial | | |
| Gorteen | D | No | 1D-2D Fluvial | | |
| Manorhamilton | C | No | 1D-2D Fluvial | | |
| Riverstown | D | No | 1D-2D Fluvial | | |
| Sligo | C | Yes | 1D-2D Fluvial | | |
| Gorteen to Collooney MPW | N/A | Yes | 1D Fluvial | | |
| Coolaney to Owenmore River MPW | N/A | Yes | 1D Fluvial | | |
| Riverstown to | N/A | Yes | 1D Fluvial | | |

| AFA | Model Output Ranking | Rating Review in AFA? | Model Type | Proposed AFA Modelling Start Date | Proposed AFA Modelling Completion Date |
|---------------------------------|----------------------|-----------------------|------------|-----------------------------------|--|
| Collooney MPW | | | | | |
| Manorhamilton to Lough Gill MPW | N/A | No | 1D Fluvial | | |

5 Risks to programme and quality

This chapter discusses the main risks to the Western CFRAM work, primarily focussing on risks to programme and quality during the modelling phase.

Risks to the project have been reviewed and are summarised below under risks to programme and risks to quality. This section has been populated following a risk workshop on 22 June 2012 as part of Progress Group meeting 8 and from the risk register compiled early in the Western CFRAM process. The risks focus on the next stages of the project, mirroring those stages covered by this inception report.

5.1 Risks to programme

Risks to programme may cause delay to delivery of the modelling and mapping outputs from the CFRAM. No specific delay time has been attributed to these risks as they are generally unknown at this time.

5.1.1 Delays to input data

| ID | Source | Consequence | Mitigation |
|----|---|---|---|
| 1 | Weather disruption likely cause of delay to topographic survey. | Delay to river modelling starting in AFAs and MPWs. | None - starting as soon as possible. |
| 3 | Delays to LiDAR survey delivery | Delay to 2D modelling starting in AFAs and MPWs. | Process being managed by OPW. Dates to be supplied as soon as possible |
| 4 | Trinity College groundwater outputs require modelling update | Groundwater study provides quantitative inputs after modelling finished requiring re-working. | Programme AFAs where groundwater is known to be an issue for late in process. |
| 5 | Environmental Constraints on survey, e.g. Freshwater pearl mussels | Delay in survey teams being able to access sensitive areas. | Mitigation process underway involving early consultation with NPWS and FWPM expert. |
| 6 | Quality issues with topographic survey mean delay in finalising data. | Survey returned for issues to be rectified. | Training of surveyors and processors, and production of guidance notes. |
| 7 | Additional topographic survey requirement identified during modelling phase | Model could be compromised by lack of some key data. | Ad-hoc survey contract set up in advance so these issues can be addressed quickly. |
| 8 | Wave overtopping data not supplied when required. | Model completion delayed. | Process being managed by OPW. |

5.1.2 Technical issues

| ID | Source | Consequence | Mitigation |
|----|--|--|---|
| 9 | Models more complex to construct than planned | Delay in completing modelling and mapping in AFAs. | Will always remain an issue. Phased modelling approach should help counteract. Simplified model could be an option. |
| 11 | Flood events during or after modelling, re-calibration | Re-visit models to incorporate recent data. Re-working of completed work. | Risk will remain until end of project. New data should be used if improves study outputs. |
| 12 | Unable to resolve hydrology / design flows | Delay, cost for further investigation where practicable. Insufficient confidence in outlines to provide reasonable economics / impacts assessment. | Early discussion of hydrology outputs so by time used in modelling issues will have been resolved. Use uncertainty in design and freeboard estimation. |
| 13 | Excessive difficulty in achieving HEP reconciliation | Hydraulic models and hydrologic estimates do not match. | Early discussion of hydrology outputs so by time used in modelling issues will have been resolved. |
| 14 | Underestimation of effort required to meet specified quality | Time spent doing modelling escalates and delays delivery. | Keep close watch on time, cost and quality. Unit managers and project manager to liaise about issues quickly. Quality planning and ensure right processes / team culture will be crucial. |
| 15 | Insufficient data to achieve an appropriately calibrated model | Have to use data available or delay while additional data collected. Greater uncertainty in model outputs. | JBA to make recommendations on where additional data may be of benefit. |
| 16 | Assumptions made by JBA about quality of data and data gaps | Model built using inappropriate data may have quality compromised and require delay while reworking. | Ensure appropriate data is being used. Check data register/ data manager etc. Data register / JBA quality assessment of important data to be shared back with original owner of the data - are they happy with the use / assessment being made. |
| 17 | Previous studies inadequate or inconsistent for use of CFRAM. | Where previous information is being used it turns out to be inappropriate and delay while alternative approach is taken. | Review previous studies early in process to determine issues. |
| 18 | Joint probability analysis proves overly complex to resolve. | Analysis becomes over complicated and delays finalising maps. | NTCG to advise on consistent approach. |
| 19 | OPW require excessive hydrology review and reworking. | Analysis becomes over complicated and delays finalising maps. | NTCG to advise on consistent approach. |
| 20 | OPW require excessive modelling review and reworking. | Analysis becomes over complicated and delays finalising maps. | NTCG to advise on consistent approach. Phased approach used to bring third party reviews into the process. |

5.1.3 Wider issues

| ID | Source | Consequences | Mitigation |
|----|---|---|---|
| 21 | LA review requires re-working of model to address issues raised | Delay in agreement on maps prior to wider issue. | Identify possible issues prior to modelling |
| 22 | Allocated time for Progress Group review not adequate for multiple departments to review maps | Delay in agreement on maps prior to wider issue. | Issue maps in drip feed as available. LA to be kept informed of progress and to be ready for reviews. |
| 23 | Methodology changes from OPW/NTCG | Re-working of completed work following change in approach. | NTCG not to change specification late in process. |
| 24 | JBA internal resourcing issues | Modelling takes longer than scheduled as modellers overstretched. | JBA to manage resources throughout CFRAM modelling to ensure sufficient resource is available. Starting with realistic resource estimates and actively managing resources to ensure availability. OPW to ensure (as far as possible) smooth workload through modelling period. |
| 25 | JBA and OPW unable to agree on contractual issues | Delay while issues resolved. | Proactive working arrangement to highlight and address issues before they become critical. |
| 26 | OPW resources - response times | Delay in review and issue of maps. | JBA and OPW to ensure review periods are clearly flagged and stuck to. |
| 27 | Lack of agreement over quality of outputs and meeting of spec | Delay following delivery of outputs. | Mechanism to reach agreement on outputs. Phased outputs and close adherence to CFRAM spec. Deal with on catchment wide basis for standard response. Mitigated by completing project in stages and having agreed plans (e.g. Inception Report) at the start of each stage that provides extra detail / clarity where needed. |
| 28 | Legal challenge to maps | Delay in being able to issue maps more widely. | Modelling process reviewed appropriately. Otherwise unknown at this stage. |

5.2 Risks to quality

Risks to quality may compromise the quality of the modelling and mapping outputs from the CFRAM.

| ID | Source | Consequences | Mitigation |
|----|--|---|---|
| 29 | Errors and omissions in Topographic Survey | Model quality reflects poor topographic survey quality. If captured then delay while rectified. | Surveyors will be trained for CFRAM work. Detailed checking of survey deliverables. Ad-hoc survey contract available to allow omissions to be captured. |
| 30 | Aerial DTM survey quality | Expect quality of LIDAR to be good. May be some local issues found. MPWs may suffer from poorer quality DTM which causes quality issues on models and flood outlines. | Checks to local topo survey in AFAs and elsewhere when possible. Review MPW flood outlines for anomalies. |

| ID | Source | Consequences | Mitigation |
|----|--|---|---|
| 31 | Insufficient data for model calibration (see 15) | In many AFAs there is little data to calibrate hydraulic models of high flow events which may mean low confidence in flood frequency predictions. | Use of temporary gauges in key risk areas to give some calibration data. |
| 32 | Errors in model build | Model quality is compromised. | Quality planning for modelling. Training of modellers and supervision by senior modellers. Phased internal review of models and outputs. Third party reviews. |
| 33 | Models more complex to construct than planned (see 9) | Simplified models may be required in some areas with quality not as high as hoped for. | Will always remain an issue. Phased modelling approach should help counteract. Simplified model could be an option to achieve programme. |
| 35 | Major inconsistency with hydrology and hydraulic modelling (see 13) | Difficult in achieving agreement with model and hydrology. Quality is compromised and uncertainty magnified. | Rating reviews to be completed prior to those AFA models. Early discussion of hydrology outputs so by time used in modelling issues will have been resolved. |
| 37 | Wave overtopping data quality not appropriate | Flood outlines in coastal areas compromised. | OPW managing this process. JBA to report back any issues with this data. |
| 38 | Joint probability approaches overly complex making communication risk difficult. | Lack of confidence in flood mapping. | NTCG to advise on consistent approach. |

6 Other stages of the CFRAM

The inception report primarily covers the hydrology and hydraulic modelling stage of the CFRAM through 2012 and 2013. In parallel with this, a Strategic Environmental Assessment (SEA) and a communications and engagement plan are being developed. These are briefly summarised below. Beyond the modelling and mapping phase there are several other stages of the CFRAM which are also listed for reference. At this stage they cannot be detailed more fully as that will depend on the outcomes of the modelling work.

6.1 Strategic Environmental Assessment (SEA)

In parallel with the CFRAM modelling and analysis work stream there is also the SEA work stream being undertaken. The SEA is reporting separately at this stage of the CFRAM and the SEA Scoping report will provide information on environmental opportunities and constraints within the Unit of Management. A summary overview of the SEA process is given in this section. The latest available Western CFRAM SEA reports can be obtained from www.westcframstudy.ie.

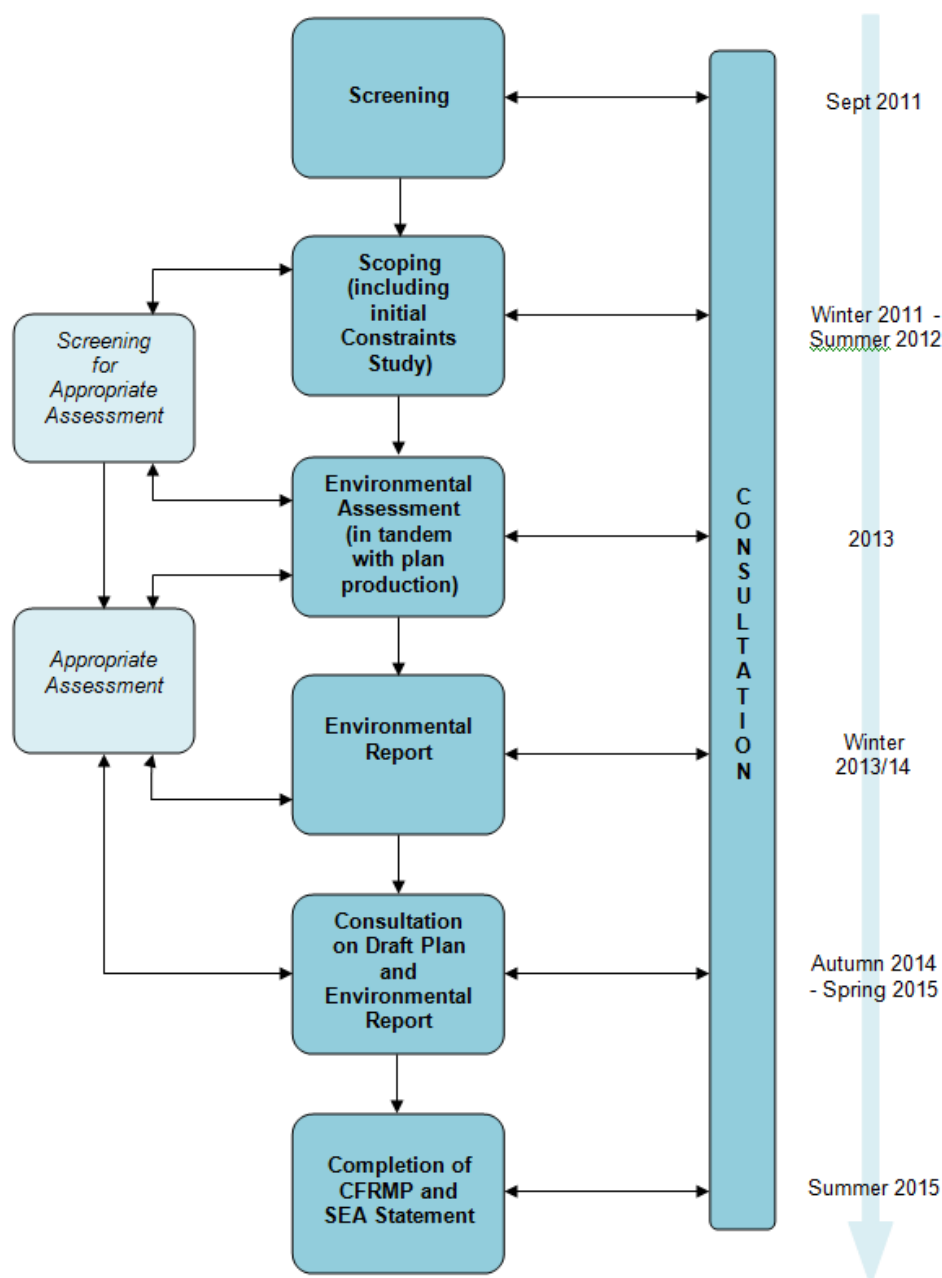
SEA is an integral part of the development of any large scale plan, programme or strategy, such as a CFRAM. It is a statutory requirement under the SEA Directive (EU Directive 2001/42/EC), which is transposed into Irish law by the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004. SEA is a formal, systematic method which is used to consider likely effects of implementing a plan or programme on the environment before a decision is made to adopt it. It also ensures environmental considerations are addressed as early as possible and in balance with technical and economic factors.

The SEA process involves a number of stages, as shown in Figure 6-1.

We are currently working on the Scoping stage of the SEA process. To-date this has involved:

- Collection and collation of baseline data for the Western RBD on a range of social and environmental receptors, including biodiversity; cultural heritage and archaeology; fisheries; soils, geology and land use; water quality and resources; geomorphology; tourism and recreation; social and health care facilities; and infrastructure. This formed the basis of a Constraints Study which has identified constraints and opportunities in the Western RBD and will then inform future FRMP production.
- GIS mapping of environmental constraints within the Western RBD.
- Review of other existing plans, policies and programmes which could potentially have in-combination effects with the CFRAM. This will ensure that the CFRAM does not conflict or contradict with other existing plans, policies and programmes in the Western RBD.
- In conjunction with the communications team, production and issue of a SEA introductory letter and questionnaire which was issued to over 40 environmental stakeholders. The purpose of this questionnaire was to initiate the consultation process, introduce the Western CFRAM process and assist with the collection of baseline data.
- Holding an SEA workshop with key environmental stakeholders. The purpose of this workshop was to identify any data gaps in the existing baseline data compiled, finalise the scope of the SEA and the discuss draft environmental objectives.

Figure 6-1: SEA process



Future work planned for the Western CFRAM SEA includes:

- Using the baseline data collected to develop set of environmental objectives for use later in the study.
- Determination of the extent and level of detail to be included in future stages of the SEA, including the identification of issues that are not relevant to the FRMP and can therefore be 'scoped out' of further consideration.
- Re-issue of the SEA questionnaire to those who have not yet responded, with the finalised list of AFAs, to try and prompt stakeholders and gather more targeted responses.

6.1.1 Habitats Directive Appropriate Assessment

The Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) and Birds Directive (Council Directive 79/409/EEC on the conservation of wild birds) are transposed into Irish law through the European Communities (Natural Habitats)

Regulations, 1997 (as amended and consolidated in 2011 by the European Communities (Birds and Natural Habitats) Regulations). The Habitats Directive requires that, in relation to SACs and SPAs, *"any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives"*.

Consequently, it will be necessary to undertake an assessment of the CFRMP proposals under the Habitats Directive. This will be carried out in parallel to the SEA process, as appropriate, with the findings used to guide the development of alternative options. The assessment will consider possible impacts on European designated sites within and outside of the study area that could be affected by recommendations of the plan, including consideration of potential downstream impacts on internationally designated conservation sites.

6.2 Communications and engagement plan

For the Western CFRAM a Communications and Engagement (CE) Plan has been developed. The objectives of the CE Plan (and CE work in general) are to:

Set out roles

This Plan sets out the current view on project roles and responsibilities.

Be the “glue”

Help the project integrate with the wider context and CFRAM programme and share information effectively. It will also help integrate the key work stages, project objectives and outputs of the Western study. This includes establishing links with Water Framework Directive (WFD) activities in the Western RBD, a requirement of the 'Floods Directive'. The team will also need to signpost stakeholders to other areas of support as appropriate (e.g. WFD activities or OPW's Minor Works Programme).

Set out procedures, including:

- Identifying relevant stakeholders / organisations and contacts. This includes those who may have a role to play in implementing the plan or process, those who can provide valuable information or advice and also those who may be impacted by a decision or activity. This is called Stakeholder Mapping.
- Stakeholder and public communication and consultation. This includes activities such as newsletters, project website, consultation days and workshops.
- Documenting how the public / stakeholders have been involved and engaged in the CFRAM, including procedures for acknowledging, recording and acting on feedback.
- Procedures for control of project communications between the project team, Steering Group and Progress Group.

Advise on the language / messaging

The CFRAM project will include many technical aspects and outputs that will need to be communicated in an efficient and effective way. Review of key materials by communications specialists and non technical staff can greatly assist in this. Jargon is a specific issue. CFRAM, FRMP, SEA, AFA, PFRA, HPW. Effective communication is hindered by jargon. Unfortunately, projects such as this CFRAM attract a lot of it.

Manage expectations

The CFRAM project is a significant exercise. Clarity is needed on what it will and won't deliver. It won't solve all problems now, but it is part of a longer term process with periodic reviews (6 yearly).

Planning and programming

A programme is needed for activities to publicise and disseminate the project data - to inform, engage and consult stakeholders and the public. The aim is to establish two way dialogue and long-term relationships with stakeholders and communities which build a greater awareness of flood risk and help understand and respond to local concerns. This is based on key work stages:

- PFRA and Flood Risk Review

- Flood Modelling and Mapping
- Strategic Environmental Assessment and Appropriate Assessment
- Development of Flood Risk Management Options

Set the team culture

This Plan has been prepared as a guide for the project team to enable time and resources to be effectively used in a co-ordinated manner, to communicate and engage with the relevant people about the most appropriate matters at the right time. The Study team aims to be regarded as active in seeking views, helpful, responsive, good communicators, honest and transparent. An approach is sought where people feel enthused, valued and included for the project duration both internally and within key stakeholders. This ethos should apply to all involved: JBA, OPW and Steering / Progress Groups.

6.3 Further stages of the CFRAM

The work detailed in the inception report is primarily focussed up to delivery of the Hydraulics Report, but the CFRAM is a project that continues beyond that point. At this stage there we cannot define the scope of the project beyond the modelling phase as the outcomes will determine the future work required. The main reports to follow later in the project are shown in Table 6-1.

Table 6-1: Main CFRAM reports for later in the project

| Title | Indicative Content |
|----------------------------|--|
| Preliminary Options Report | Identification of viable actions and measures to reduce flood risk across spatial scales through UoM, catchment, AFA to key defined individual receptors (IRRs). Also to include SEA reporting. |
| Flood Risk Management Plan | Sets out the management policies, strategies actions and measures to be implemented by OPW and other organisations. This shall be non-technical and suitable for use by politicians, stakeholders and the public. |
| Draft Final Report | The Draft Final Report will detail the development of the Flood Risk Management Plans and include: <ul style="list-style-type: none"> – Draft outline design drawings, plans and documents of the preferred options (measures). – Draft SEA Environmental Reports and Non-Technical Summaries, – Draft Appropriate Assessment Screening Statements, – Initial Draft Flood Risk Management Plans. |
| Final Report | Development of the Draft Final Report having reviewed all submissions made during the six (6) month public and stakeholder consultation period. |

At a later stage in the project (probably late 2013) the required work for these reports will be set out in detail in further work plans having reviewed the modelling outputs.

Figures

A3 Figures from Chapter 4 for each AFA are supplied as follows:

Figure 4-2: Ballymote modelling details map

Figure 4-4: Ballysadare northern modelling details map

Figure 4-6: Ballysadare southern modelling details map

Figure 4-8: Collooney modelling details map

Figure 4-10: Coolaney modelling details map

Figure 4-12: Gorteen modelling details map

Figure 4-14: Manorhamilton modelling details map

Figure 4-16: Riverstown modelling details map

Figure 4-18: Sligo modelling details map

Appendices

- A Incoming data register**
- B Rating Review**
- C Rainfall Analysis**
- D Event Analysis**
- E Hydrograph Width Analysis**
- F Flood Peak Analysis**
- G Flood History Timeline**



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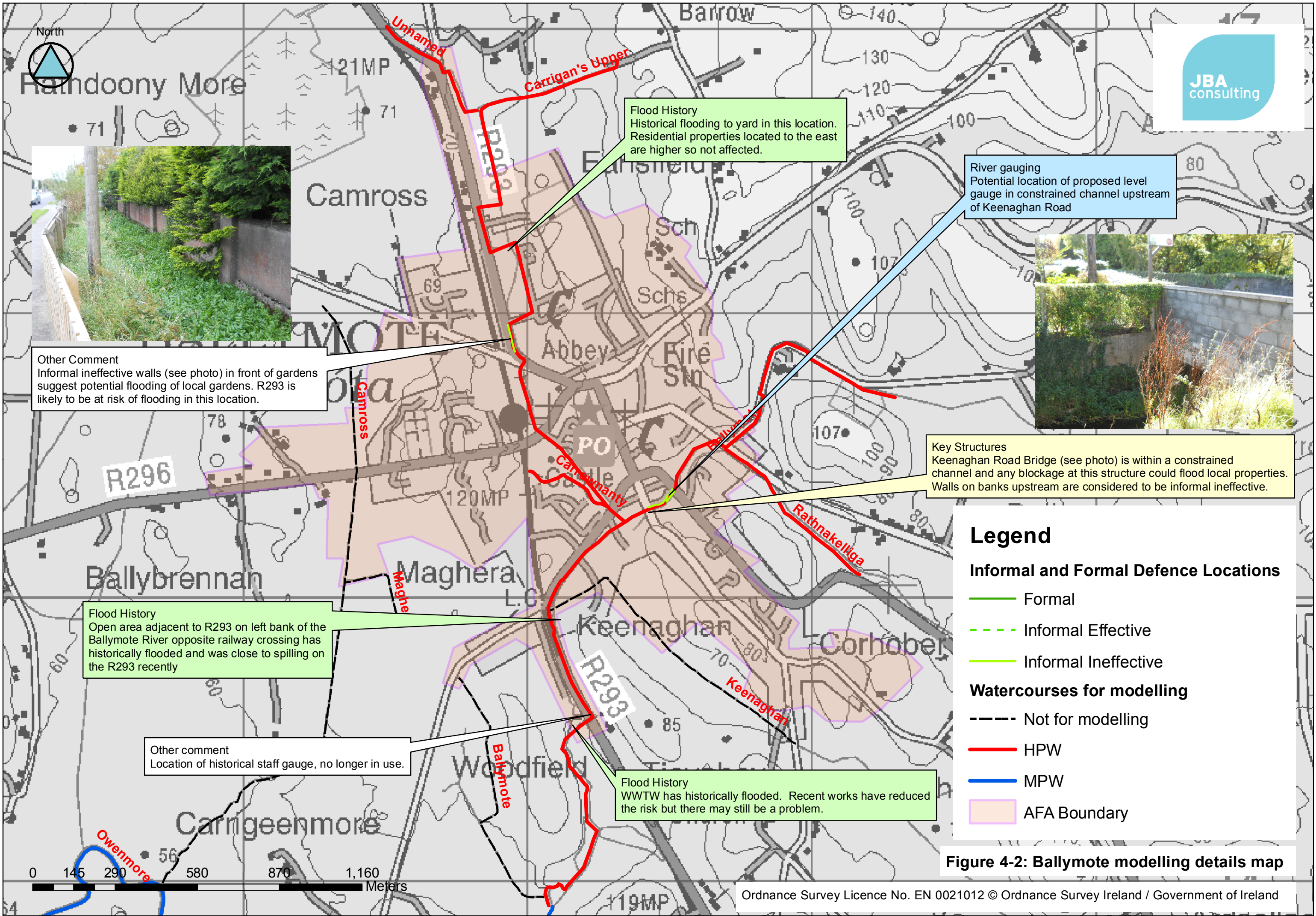


Figure 4-2: Ballymote modelling details map



Other comment
Original alignment of watercourse appears to have been moved to run in two parallel drains either side of the highway (see photo).



Key Structures
Tidal flap gates on watercourse on small culvert (see photo) downstream of the R292. Photos of the tidal flap gates suggest they may not seal completely.

Key Structures
Series of culverts beneath the N4 roundabout

Flood History
No flood history at local industrial sites which are reportedly designed to the 100yr design level. Historically road used to flood until recent works at the roundabout.

Legend

Informal and Formal Defence Locations

- Formal
- - - Informal Effective
- Informal Ineffective

Watercourses for modelling

- - - Not for modelling
- HPW
- MPW
- AFA Boundary

Figure 4-4: Ballysadare northern modelling details map



JBA
consulting



Key Structures
Hydropower plant located on the left bank of the Ballysadare River. The plant takes flow immediately downstream of the N59 Road Bridge along a channel discharging adjacent to the 6m weir at the downstream limit (see photo above).

Flood History
Local properties may be at risk of flooding

Key Structures
N59 Road Bridge is potentially susceptible to debris build up on its piers (see photo below).



Key Structures
The Ballysadare River drops steeply through this reach through a long series of weirs (see photo above) from a short distance downstream of the N59 Road Bridge to its outfall to the sea. The final weir is approximately 6m in height.

River gauging
Ballysadare River gauge located on left bank upstream of N59 Road Bridge

Flood History
New build properties on right bank would have flooded in the 1947 flood event.

Other Comment
Informal ineffective walls of left bank

Flood History
Left bank floods with possible flood route to upstream areas beneath railway bridge.

Legend

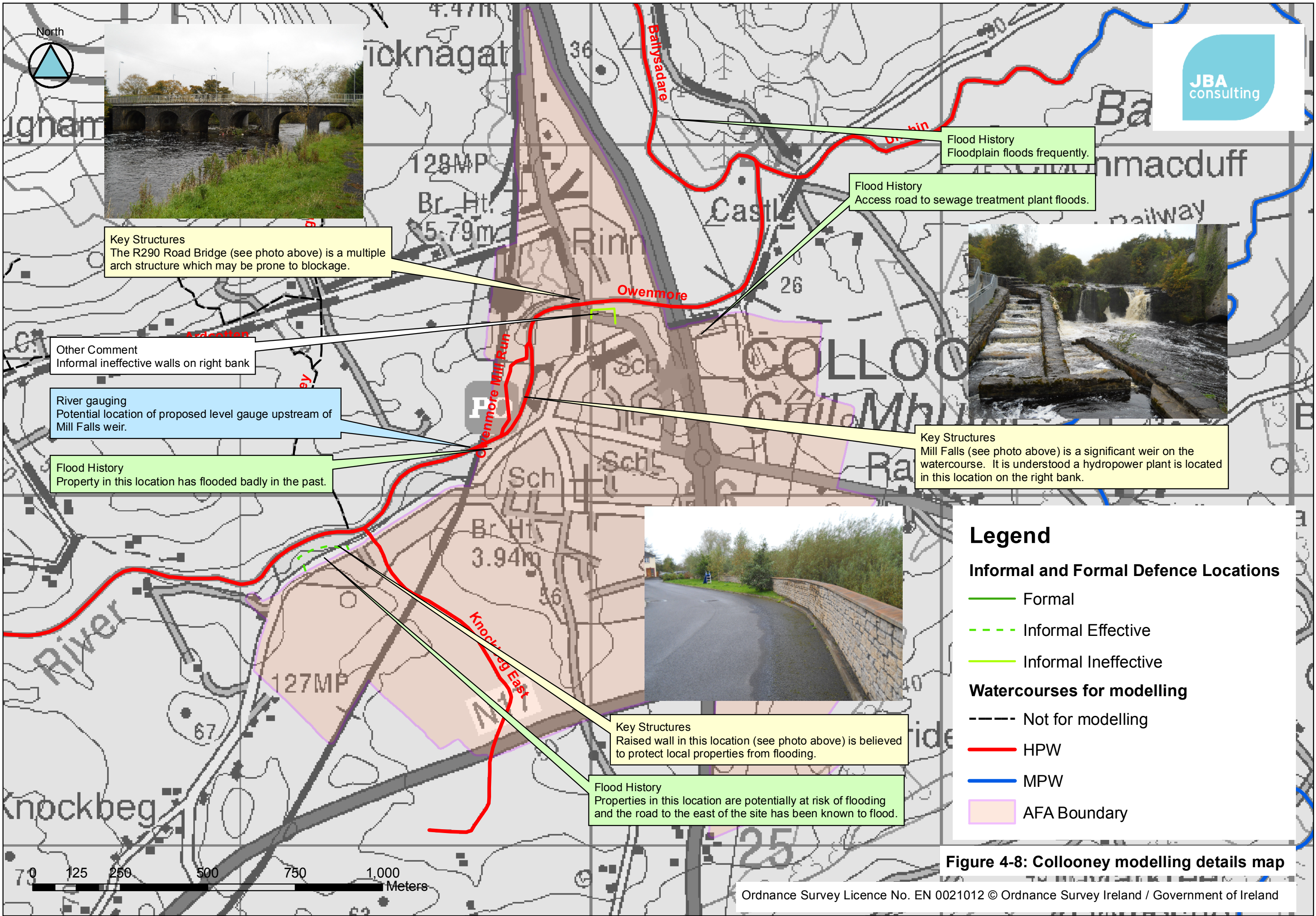
Informal and Formal Defence Locations

- Formal
- Informal Effective
- Informal Ineffective

Watercourses for modelling

- Not for modelling
- HPW
- MPW
- AFA Boundary

Figure 4-6: Ballysadare southern modelling details map





Key Structures
Rathbarren Stream Road Bridge (see above photo) constrains the channel and may exacerbate flood risk on right bank if it becomes blocked. It is noted that flood waters may simply overtop the structure.

Flood History
First property downstream of the Coolaney Road Bridge on right bank floods.

Flood History
Old WWTW in this location flooded, the new one has been raised but flooding may still be a problem. The WWTW access road floods.

River gauging
Potential location of a proposed level gauge on the Rathbarren Stream.

Other comment
Potential flow route over right bank if blockage at structures on Rathbarren Stream is an issue. Flood waters however may simply overtop the downstream structures.

Other Comment
Informal ineffective walls surround housing estate (see photo below) on left bank of Rathbarren Stream.



Legend

Informal and Formal Defence Locations

- Formal
- Informal Effective
- Informal Ineffective

Watercourses for modelling

- Not for modelling
- HPW
- MPW
- AFA Boundary

Figure 4-10: Coolaney modelling details map



Gurteen

Key Structures
Informal effective wall (see photo below) located on right bank surrounds local housing estate. The effectiveness of this structure should be reviewed.



Other Comment
Informal ineffective walls on right bank surround local housing estate but can be bypassed in the centre of the estate.

River gauging
Possible location of proposed level gauge site on Gurteen Stream.

Flood History
Corner of WWTW in this location has flooded historically. This has since been filled and it is no longer considered to be a problem.

Flood History
Land to the right of the culvert inlet has historically flooded. The worst instance of flooding occurred when the culvert itself became blocked. The trash screen was installed to prevent this reoccurring.

Gorteen

Key Structures
R294 Culvert (see photo below) potentially prone to blockage. Overland flooding from this location would potentially impact properties in the town.



Ragwood

Ragwood

Legend

Informal and Formal Defence Locations

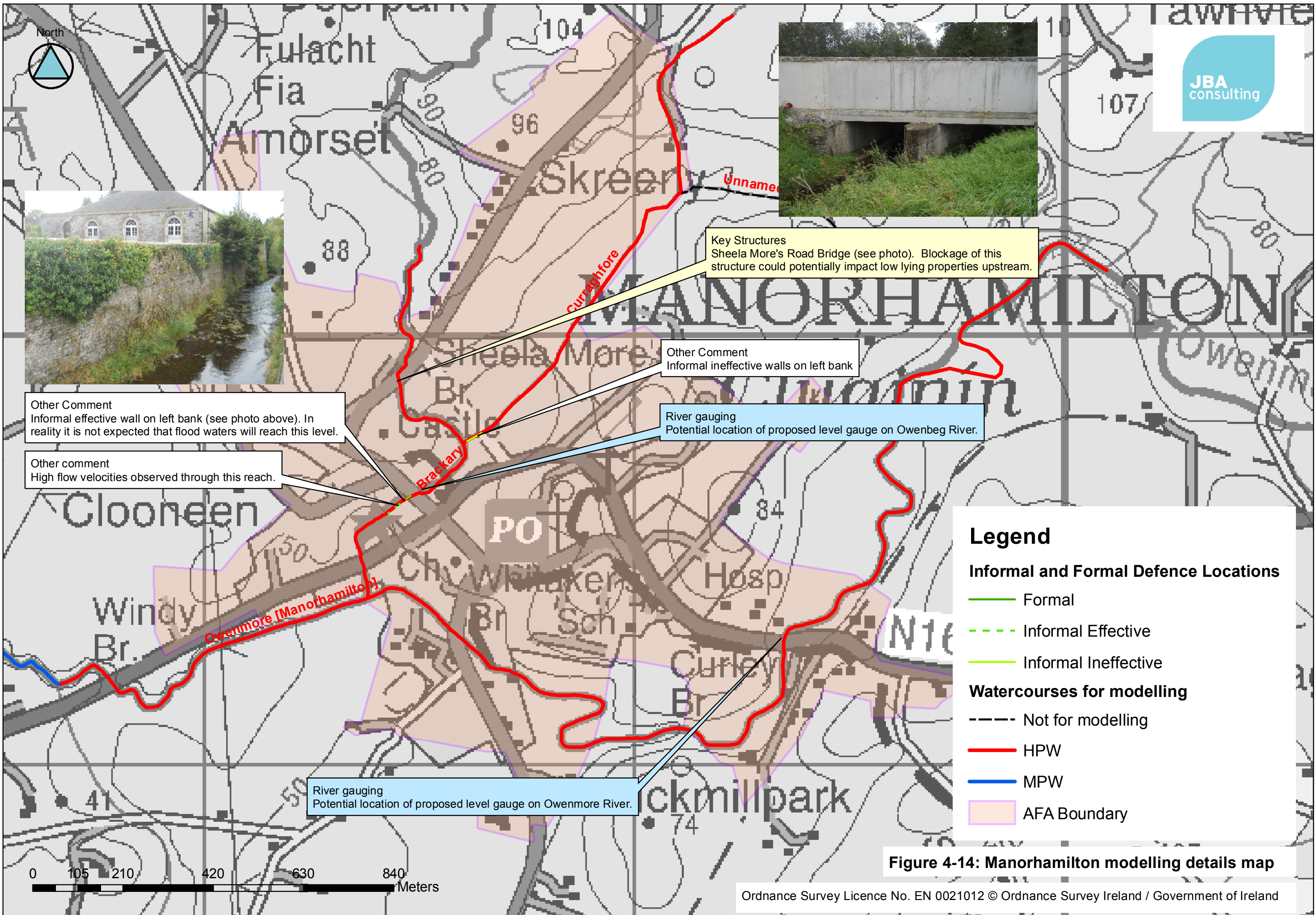
- Formal
- - - Informal Effective
- Informal Ineffective

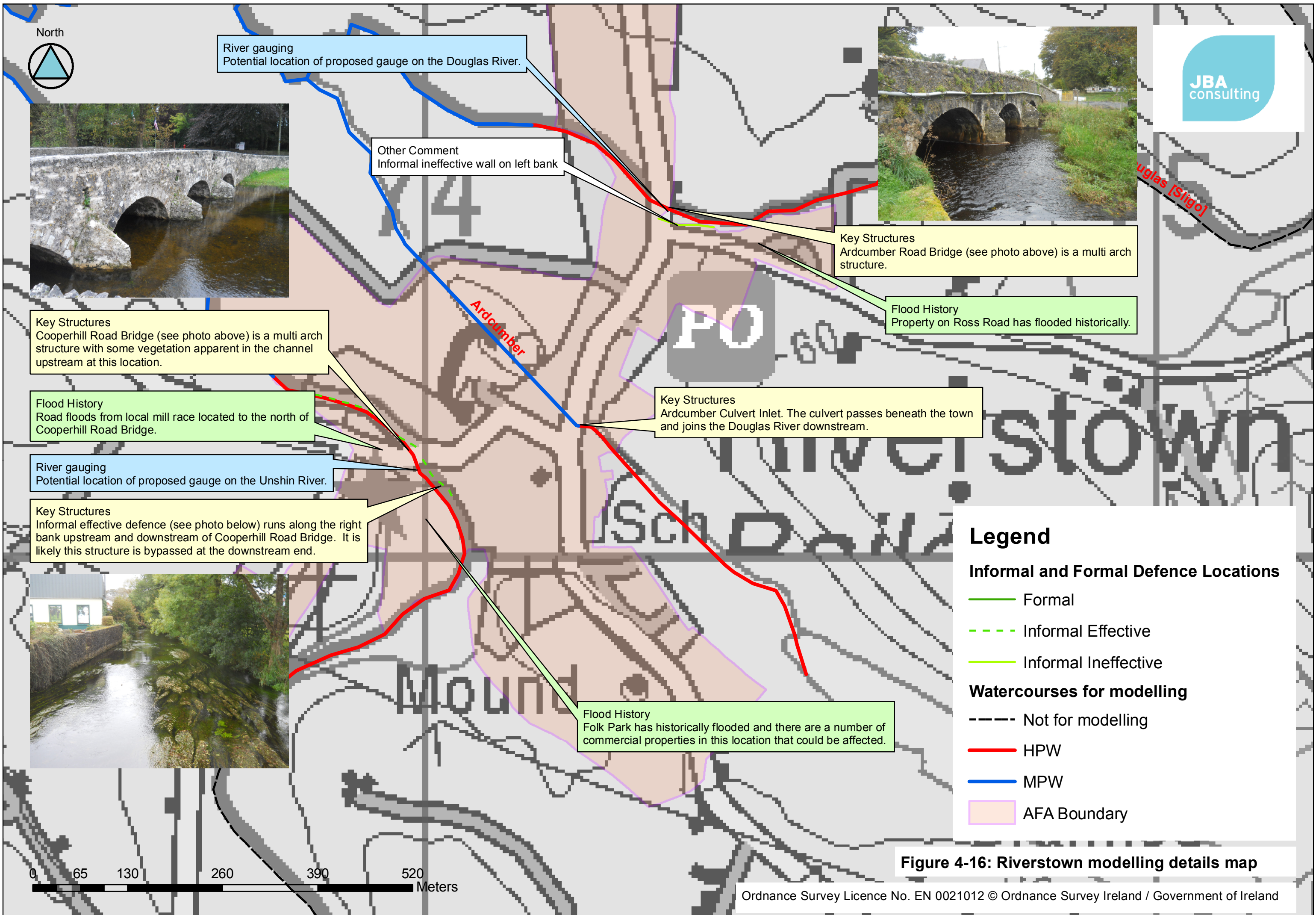
Watercourses for modelling

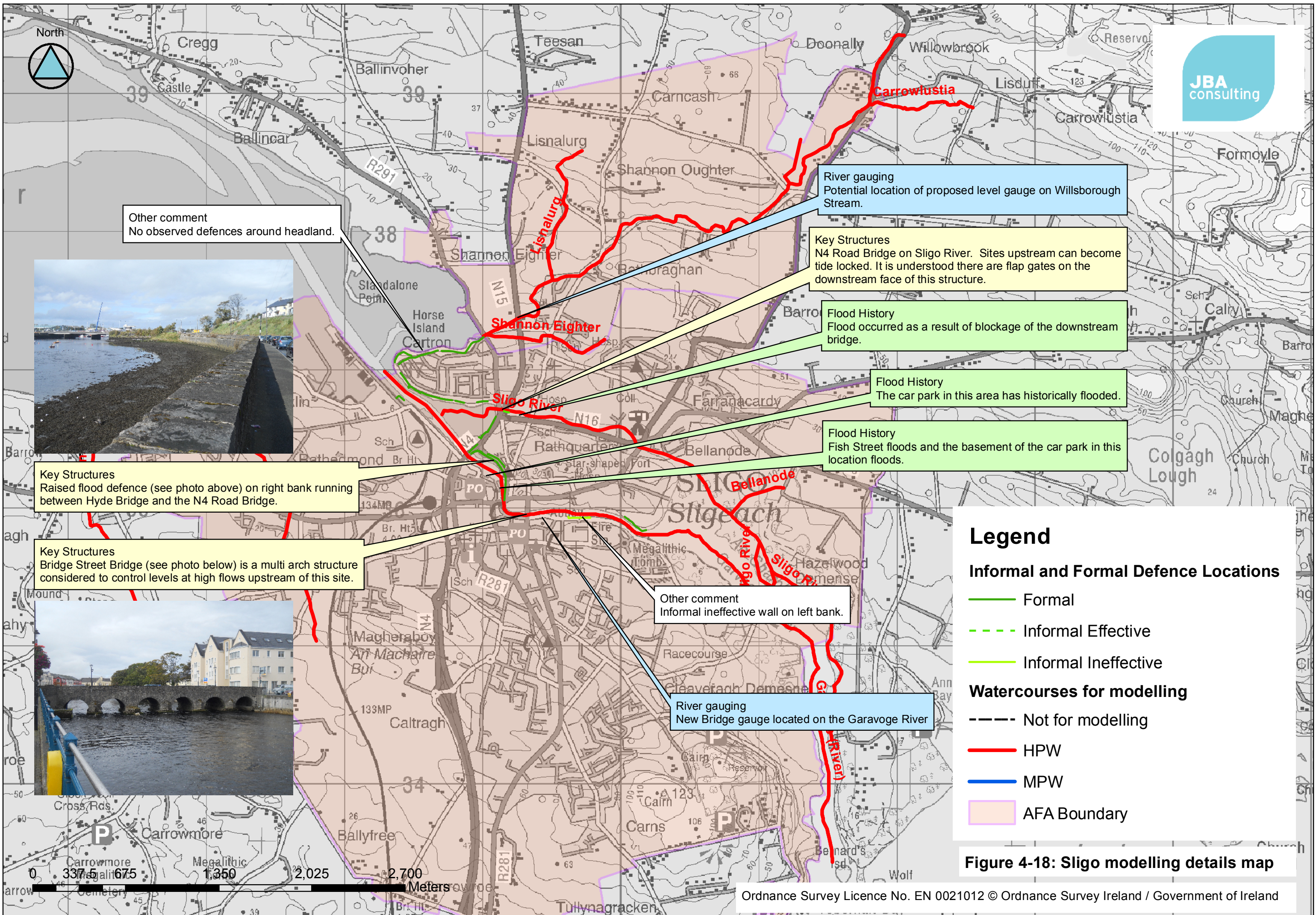
- - - Not for modelling
- HPW
- MPW
- AFA Boundary

0 87.5 175 350 525 700 Meters

Figure 4-12: Gorteen modelling details map







Appendix A - DataRegister_Downloaded_290812.xls

| | | | | | | | | | | | | | | | Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | |
|---------------------------|---------------|----------------|---|-------------------|---------------------|---------------|---------------------------|--|----------------------------|--|---------------------|----------------------------|-----------------|-----------------|--|-------------|---------------|-----------------------|---------------------------|-------|------------|------------|-----------------------|---------------------|------------------------------------|------------------|--|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | CIS / Core Data | OPW Spec / Guidance | Topo Survey | SEA / Nat Env | Flooding / Hydraulics | Hydrometr ics / Hydrology | Comms | Econ / MCA | H&S / PSDP | Assets / Engineer ing | Coastal hydraulic s | SEA - Spatial Planning / Human Env | General comments | |
| 33 | 09/08/2011 | EPA | 110615 - Register_of_Hydrometric_Stations_in_Ireland-January2011, produced by OPW | OPW | Excel and MapInfo | 1 | DSF | Excel Spreadsheet and MapInfo Tables of EPA Register | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 34 | 09/08/2011 | OPW | OPW Hydrometrics: Annual Maxima, Gaugings, Q 15min Data, Rating Equations, Staff Gauges Zero, WL 15min Data, Photographs, produced by OPW | OPW | Text / csv zipped | 1 | DSF | Used for inception and flood estimation | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 35 | 09/08/2011 | EPA | EPA river level and flow data including AMAX and continuous data for rating review sites only | OPW | | 1 | DSF | Rest of data provided on 13 Oct 11 | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 36 | 09/08/2011 | OPW | 110113 Fhm_floods.TAB | OPW | Mapinfo | 1 | SPW | Snap shot of the Flood Hazard Mapping database, saved on 13th January 2011. File contains historical flood event point locations. Can get updated data set from www.floodmaps.ie | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | Yes | | | | Yes | | | | | | | | | |
| 37 | 09/08/2011 | OPW | Embankments Scheme V2 issue.TAB, Benefit Scheme V2 issue.TAB, Bridge_Schemes V2_issue.TAB, Channels_Scheme_V2_issue.TAB produced by OPW | OPW | Mapinfo | 1 | SPW | OPW Embankment layer for OPW schemes with the Shannon catchment, includes some data in the western CFRAM catchment. | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | Yes | | | | | | | | | | | | | |
| 38 | 09/08/2011 | Met Eireann | Rainfall logger (24hr storage), Daily gauges, (Met Eireann/Data files/Rainfall/Daily Rainfall), produced by Met Eireann | OPW | text files | 1 | DSF | By Met Catchment Area. Pdf file also included showing relationship between Met catchments and Hydrometric Areas. | Yes | Letter of commitment concerning the use of Met Eireann Data.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 39 | 09/08/2011 | Met Eireann | Rainfall logger (hourly), Synoptic Stations, (Met Eireann/Data files/Rainfall/Hourly Rainfall), produced by Met Eireann | OPW | text files | 1 | DSF | By Met Catchment Area | Yes | Letter of commitment concerning the use of Met Eireann Data.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 40 | 09/08/2011 | Met Eireann | Evaporation Data, Synoptic Stations (Met Eireann/Data files/Evaporation), produced by Met Eireann | OPW | text file | 1 | DSF | National dataset | Yes | Letter of commitment concerning the use of Met Eireann Data.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 41 | 09/08/2011 | Met Eireann | Pot Evapotranspiration, Synoptic Stations (Met Eireann/Data files/Pot Evapotranspiration), produced by Met Eireann | OPW | text file | 1 | DSF | National dataset | Yes | Letter of commitment concerning the use of Met Eireann Data.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 42 | 09/08/2011 | Met Eireann | Soil Moisture Deficit, Synoptic Stations (Met Eireann/Data files/SMD), produced by Met Eireann | OPW | text file | 1 | DSF | National dataset | Yes | Letter of commitment concerning the use of Met Eireann Data.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 43 | 09/08/2011 | Met Eireann | Air Pressure | | text files | | GC / JD | Available on request | | | | | | | | | | | | | | | | | | | |
| 44 | 09/08/2011 | Met Eireann | Temperature | | text files | | GC / JD | Available on request | | | | | | | | | | | | | | | | | | | |
| 45 | 09/08/2011 | Met Eireann | Wind Speed and Direction | | text files | | GC / JD | Available on request | | | | | | | | | | | | | | | | | | | |
| 46 | 09/08/2011 | Met Eireann | Soil temperature | | - | | GC / JD | Available on request | | | | | | | | | | | | | | | | | | | |
| 47 | 09/08/2011 | Met Eireann | 2199_MET_Climate Stationss SH; 2199_MET_Complete Rainstations SH; 2199_MET_Daily Rain Recorder Stations SH; 2199_MET_Daily Rainfall Stations SH; 2199_MET_Monthly Rainfall Stations SH; 2199_MET_Synoptic Stations-SH; 2199_MET_Weekly Rain Recorded Stations SH; 2199_Hydrometric Stations SH, produced by Met Eireann | OPW | GIS files, excel | 1 | DSF | Met Eireann spatial files. Some may be repeats. | Yes | Letter of commitment concerning the use of Met Eireann Data.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 48 | 09/08/2011 | Met Eireann | Rainfall Radar | | - | | DSF | Available on request (for particular storm events) | | | | | | | | | | | Yes | | | | | | | | |
| 49 | 09/08/2011 | OPW | 110310_Final_Database, 110309_ALL_VAL_Post Round Two -MA, MapInfo Tabs of Points and Areas, produced by OPW | OPW | Access & MapInfo | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | Yes | | | | | | | | | | | | | |
| 50 | 09/08/2011 | OPW | PFRA GW Final Rpt 30-06-10, with pictures, High Level Summary - GW 30-06-10, produced by OPW | OPW | pdf | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 51 | 09/08/2011 | OPW | 2198_PFRA breakdown.TAB, produced by OPW | OPW | MapInfo | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | Yes | | | | | | | | | | | | | |
| 52 | 09/08/2011 | OPW | EX6335_FRAM_National-pluvial-screening-Ireland_R2-0, produced by OPW | OPW | pdf | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | Yes | Yes | | | | | | | | |
| 53 | 09/08/2011 | OPW | 1721_DOC_OPW_100208 Flood Data Collection PDF Form V1.6, produced by OPW | OPW | Excel | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | | Yes | | | | | | | |
| 54 | 09/08/2011 | OPW | Flood Data Collection brochure 2008, produced by OPW | OPW | pdf | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | Yes | Yes | | | | | | | | |
| 55 | 09/08/2011 | OPW | RPS User for www.floodmaps.ie.xls, produced by OPW | OPW | xls | 1 | RD / JD | | Yes | | Project End | | Western | | | | | Yes | Yes | | | | | | | | |
| 56 | 09/08/2011 | OPW | Username: FHMJBA Password: morris01 | OPW | | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 57 | 09/08/2011 | OPW | Approximately 49 images from flooding.ie, produced by OPW | OPW | jpeg | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 58 | 09/08/2011 | OPW | Acquired as part of Plan, Prepare, Protect programme | OPW | | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | | | | | | | | | |
| 59 | 09/08/2011 | OPW | 110520_Fhm_floods (MapInfo) 110517_FHM_DBA_MD_(FLOODS, REPORTS, PRESS_ARCHIVE) (Excel), produced by OPW | OPW | MapInfo / Excel | 2 | RD / JD | Newer versions may be available. | Yes | | Project End | | Western | | | | | | Yes | | | | | | | | |
| 60 | 09/08/2011 | OPW | Log in details also available to Consultant to download newer versions | OPW | | 1 | GC / JD | 5 m resolution | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 61 | 09/08/2011 | EPA | xxxxxx_yyyyyy_dtm_5m_ing (where xxxxxx_yyyyyy is the co-ords of the bottom left corner of a 5km wide tile), produced by OPW | OPW | MapInfo | 1 | GC / JD | 20 m resolution | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 62 | 09/08/2011 | EPA | Includes InterMap Final Report on project. | OPW | GIS files | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 63 | 09/08/2011 | OSI | hDTM (20m resolution hydrologically corrected DTM) (EPA-20m hDTM/Disc 4-Western RBD) | OPW | | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Western | | | | | | Yes | | | | | | | | |
| 64 | 09/08/2011 | OSI | Data in folders by hydrometric area, produced by EPA | OPW | Mapinfo | 1 | GC / JD | No information relating to release date, version or currency. | Yes | | Project End | OSI Licence No. EN 0021012 | Western | | | | | | Yes | | | | | | | | |
| 65 | 09/08/2011 | OPW | LIDAR & Orthophotography/Coastal, produced by OPW | OPW | Various | 1 | GC / JD | Made up of several datasets and formats. | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | Galway & Sligo | | | | | | Yes | | | | | | | | |
| 66 | 09/08/2011 | OPW | Aerial photography, produced by OPW | OPW | Mapinfo | 1 | GC / JD | | Yes | | Project End | | Western | | | | | | Yes | | | | | | | | |
| 67 | 09/08/2011 | OPW | Oai OrthoPhotography | OPW | | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 68 | 09/08/2011 | OPW | 2202_110408_Channel_Schemes_West, produced by OPW | OPW | MapInfo | 1 | RD / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 69 | 09/08/2011 | OPW | 2202_110408_Embankments_Scheme_West, produced by OPW | OPW | MapInfo | 1 | GC / JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 70 | 09/08/2011 | OPW | Embankments file Version2 | OPW | | 1 | JD | Available to download from www.floodmaps.ie | Yes | | Project End | | National | | | | | | Yes | | | | | | | | |
| 71 | 09/08/2011 | EPA? | Benefit Scheme V2 issue, produced by OPW | OPW | MapInfo | 1 | JD | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 72 | 09/08/2011 | OPW FSU | Lakes, produced by OPW | OPW | MapInfo | 1 | JD | Fairly low resolution. Presumed spatial reference is Irish National Grid but no information on this or and explanation of the attributes associated with the data | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | | | | | | Yes | | | | | | | | |
| 73 | 09/08/2011 | OPW (FSU) | OPW FSU | OPW | ESRI | 1 | JD | Fairly low resolution data. Some alignment issues with raster basemaps in certain locations. No information on spatial reference or attributes associated with data. | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | Project End | | National | Yes | | | | | Yes | | | | | | | | |
| 74 | 09/08/2011 | OPW | Letter of commitment concerning the use of Data provided, produced by OPW | OPW | Word doc | 1 | RD / JD | To be signed and returned to OPW | N/A | | Project End | | N/A | Yes | | | | | | | | | | | | | |
| 75 | 09/08/2011 | Met Eireann | Letter of commitment concerning the use of Met Eireann Data, produced by Met Eireann | OPW | Word doc | 1 | RD / JD | To be signed and returned to OPW | N/A | | Project End | | N/A | Yes | | | | | | | | | | | | | |
| 76 | 09/08/2011 | SERTIT | SAFER022_SERTIT_Letter of Commitment - 100513, produced by OPW | OPW | Word doc | 1 | RD / JD | To be signed and returned to OPW | N/A | | Project End | | N/A | Yes | | | | | | | | | | | | | |
| 77 | 09/08/2011 | OPW | Corporate Identity Manual Full, produced by OPW | OPW | pdf | 1 | RD / JD | OPW Corporate Identity Manual Full | N/A | | Project End | | N/A | Yes | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | | |
|---------------------------|---------------|--|---|--|------------------------------|---------------|---------------------------|---|----------------------------|-----------------------|----------------|---------------------|--|--|-----------------|---------------------|-------------|---------------|-----------------------|--------------------------|-------|------------|------------|----------------------|--------------------|------------------------------------|------------------|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data | Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | CIS / Core Data | OPW Spec / Guidance | Topo Survey | SEA / Nat Env | Flooding / Hydraulics | Hydrometrics / Hydrology | Comms | Econ / MCA | H&S / PSDP | Assets / Engineering | Coastal hydraulics | SEA - Spatial Planning / Human Env | General comments |
| 72 | 09/08/2011 | OPW | Logos | OPW | GIF, jpeg, bitmap, EPS | 1 | RD / JD | OPW logo x 4 | N/A | | | Project End | | Suir | Yes | | | | | | | | | | | | |
| 73 | 09/08/2011 | EPA | 100209_EPA Feedback on Suir CFRAMS Scoping Report, produced by EPA | OPW | pdf | 1 | RD / JD | Suir Scoping Report comments from EPA | N/A | | | Project End | | Fingal & East Meath | Yes | | | | | | | | | | | | |
| 74 | 09/08/2011 | EPA | 2105_TECH_090625_EPA Submission on SEA scoping , produced by EPA | OPW | pdf | 1 | RD / JD | FEMFRAM Scoping Report comments from EPA | N/A | | | Project End | | Fingal & East Meath | Yes | | | | | | | | | | | | |
| 75 | 09/08/2011 | NPWS | G2010-633 npws obs 06.05.11.2 , produced by NPWS | OPW | pdf | 1 | RD / JD | NPWS comments on FEMFRAM AA | N/A | | | Project End | | Fingal & East Meath | Yes | | | | | | | | | | | | |
| 76 | 09/08/2011 | OPW | 1833 - EML - IN - 100105 - TOMahony - SEA_AA_CFRMP, produced by OPW | OPW | pdf | 1 | RD / JD | Email | N/A | | | Project End | | Lee | Yes | | | Yes | | | | | | | | Yes | |
| 77 | 09/08/2011 | EPA | LCFRAMS Draft Plan SEA ER AA Review Feedback 23 12 09, produced by OPW | OPW | pdf | 1 | RD / JD | SEA and AA EPA feedback | N/A | | | Project End | | Lee | | | | Yes | | | | | | | | Yes | |
| 78 | 09/08/2011 | OPW | Various Files, produced by OPW | OPW | pdf, Word | 1 | RD / JD | Emails x 5. Non Technical Summary with review comments. | Yes | | | Project End | | Lee | Yes | | | | | | | | | | | | |
| 79 | 09/08/2011 | EPA | 1833_EML_IN_100430_EPA - Comments and Feedback on Draft CFRMP_SEA_AA, produced by EPA | OPW | pdf | 1 | RD / JD | Email and feedback | Yes | | | Project End | | Lee | | | | Yes | | | | | | | | Yes | |
| 80 | 09/08/2011 | EPA | 1833_RPT_IN_100517_EPA - CFRAMS EPA Comments and Objectives-1, 05/08/2011, produced by EPA | OPW | Word doc | 1 | RD / JD | EPA Preliminary Comments 17.05.2010 | Yes | | | Project End | | Lee | | | | Yes | | | | | | | | Yes | |
| 81 | 09/08/2011 | OPW | PFRA Monument Vulnerability table - Rev B - 110526, produced by OPW | OPW | Excel | 1 | RD / JD | Summary of Monument Types in National Monuments Data Series | Yes | | | Project End | | National | Yes | | | | | | | | | | | | |
| 82 | 09/08/2011 | OPW | SAC - Vulnerability Assessment - MMG-NPWS - 110607, produced by OPW | OPW | Excel | 1 | RD / JD | SAC Habs & Species Assessment and SAC Overall Site Classification | Yes | | | Project End | | National | Yes | | | | | | | | | | | | |
| 83 | 09/08/2011 | OPW | SPA - Vulnerability Assessment - MMG-BW1 - 110607, produced by OPW | OPW | Excel | 1 | RD / JD | SPA - Classification | Yes | | | Project End | | National | Yes | | | | | | | | | | | | |
| 84 | 09/08/2011 | | Defence Asset Database 20110203_Setup and Blank Database, produced by OPW | OPW | Mapinfo, excel, AutoCAD, jpg | 2 | JLC | | Yes | | | Project End | | National | | | | | | | | | | | Yes | | |
| 85 | 09/08/2011 | OPW LA | Executable version of the database, produced by OPW | OPW | Mapinfo, excel, AutoCAD, jpg | 2 | JLC | Not populated with any data | Yes | | | Project End | | National | | | | | | | | | | | Yes | | |
| 85b | 09/08/2011 | OPW LA | Existing Survey Data from existing studies | | Mapinfo, excel, AutoCAD, jpg | 1 | JLC | | Yes | | | Project End | | Clare | | | Yes | | | | | | | | | | |
| 86 | 09/08/2011 | Clare Co Co | Various map info files, produced by Clare Co Co | OPW | Mapinfo | 1 | GC / JD | | Yes | | | Project End | | Clare | Yes | | | | | | | | | | | | |
| 87 | 09/08/2011 | Galway | Various map info files, produced by Galway Co Co | OPW | Mapinfo | 1 | GC / JD | | Yes | | | Project End | | Galway | Yes | | | | | | | | | | | | |
| 88 | 09/08/2011 | Mayo | Various map info files, produced by Mayo Co Co | OPW | Mapinfo | 1 | GC / JD | | Yes | | | Project End | | Mayo | Yes | | | | | | | | | | | | |
| 89 | 09/08/2011 | Sligo | Various map info files, produced by Sligo Co Co | OPW | Mapinfo | 1 | GC / JD | | Yes | | | Project End | | Sligo | Yes | | | | | | | | | | | | |
| 90 | 15/08/2011 | OPW | Phase 4 W Coast - Various files produced by OPW West coast outlines have now been superseded. See details below. JLC 27/10/2011 12:50:34 | OPW | PDF Shapefile | 2 | RD / JD | Missing data identified. Updated data subsequently supplied. | Yes | | | Project End | Please note that this information is being issued for use on the Western CFRAM only and should not be issued to any third party without prior written approval from OPW. | Western | Yes | | | | | | | | | | | | |
| 91 | 15/08/2011 | OPW | Phase 5 NW Coast - Various files produced by OPW | OPW | PDF Shapefile | 1 | RD / JD | | Yes | | | Project End | Please note that this information is being issued for use on the Western CFRAM only and should not be issued to any third party without prior written approval from OPW. | North Western | Yes | | | | | | | | | | | | |
| 92 | 17/08/2011 | Donegal CoCo | Development Boundries TAB file produced by Donegal Co Council | Lucia Friel Donegal CoCo | Mapinfo | 1 | MC / LF | Development Boundries for Donegal | Yes | | | Project End | | Donegal | Yes | | | | | | | | | | | | |
| 93 | 09/08/2011 | Monaghan Co CO | Development Boundries TAB file produced by Monaghan Co Council | Toirleach Gormley Monaghan CoCo | Mapinfo | 1 | MC / TG | Development Boundries for Monaghan | Yes | | | Project End | | Monaghan | Yes | | | | | | | | | | | | |
| 94 | 30/08/2011 | Galway City Council | Report 'Impact of proposed remediation measures on flooding at Southpark and Grattan Road Galway.' by Hydro Environmental Ltd | Sinead Johnstone (Galway City Council) | pdf | 1 | CNS | 2008 assessment of tidal and fluvial risks to site at mouth of Corrib. | Yes | | | Project End | | Galway | | | | | Yes | Yes | | Yes | | | | | |
| 95 | 7 Sept 11 | OPW | Additional hydrometric data for rating reviews | Ger Cafferkey | Mixed | 1 | DSF | As for other hydrometric data | Yes | | | Project End | | Western | | | | | | Yes | | | | | | | |
| 96 | 7 Sept 11 | OPW | HWA software | Ger Cafferkey | Mixed | 1 | DSF | Includes large amount of hydrometric data for analysis by the program (deleted the data for stations outside Western RBD) | Yes | | | | | N/A | | | | | | Yes | | | | | | | |
| 97 | May 2011 | OPW | Flood points Western CFram, Flood Zone A Western CFram, Flood Zone B Western CFram, WesternCFramRivers_APSR, WesternCFramRivers_APSR_RR | OPW | Shapefile | 1 | JLC | Supplied as part of the tender. Zip files also exist in same location. | Yes | | | ? | | Western | Yes | | | | | | | | | | | | |
| 98 | May 2011 | OPW | Preliminary material supplied with tender. Flood Risk Review Areas, Printscreens for Western CFram, Printscreens Neaghbann and NorthWest RR, pdf maps. | OPW | Excel, Word, pdf | 1 | JLC | Supplied as part of the tender. Zip files also exist in same location. | Yes | | | ? | | Western | Yes | | | | | | | | | | | | |
| 99 | | | 2202_TECH_110215_WESTERN_LHM_all_region.shp, 2202_TECH_110304_WESTERN_RBD_region.shp, 2202_TECH_110316_WESTERN_RISK REVIEW_point.shp, 2202_TECH_110401_WESTERN_APSR_point.shp, 2202_TECH_110407_WESTERN_Met_Stations_point.shp, 2202_TECH_110408_WESTERN_CHANNEL_SCHEMES_polyline.shp, 2202_TECH_110408_WESTERN_DRAINAGE_DISTRICTS_point.shp, 2202_TECH_110408_WESTERN_DRAINAGE_DISTRICTS_region.shp, 2202_TECH_110408_WESTERN_EMBANKMENTS_SCHEME_polyline.shp, 2202_TECH_110408_WESTERN_Hydrometric_Gauges for Rating Review_point.shp, 2202_TECH_110408_WESTERN_HYDROMETRIC_STATIONS_point.shp, 2202_TECH_110411_WESTERN_APSR_DISTANCES_polyline.shp | OPW | Shapefile | 1 | ? | | Yes | | | ? | | Western | | | | | | | Yes | | | | | | |
| 100 | | | 2202_TECH_110418_NEAGHBANN_RR_point.shp, 2202_TECH_110418_NORTHWEST_RR_point.shp, 2202_TECH_110426_NWNBA_PFRA_region.shp | OPW | Data file | 1 | ? | Supplied as part of the tender. | Yes | | | ? | | Western | Yes | | | | | | | | | | | | |
| 101 | | OPW | Tender documents. 2202_SPCF_OPW_110427_Western CFram Study - PB - Final.pdf, 2202_SPCF_OPW_110428_Western CFram Study - ITT - Final.pdf | OPW | pdf | 1 | | OPW tender documents. | Yes | | | | | Western | Yes | | | | | | | | | | | | |
| 102 | | OPW | 1718_FSU_data.zip | OPW | Multiple | 1 | DSF | Flood Studies Update data and reporting. | Yes | | | ? | | National | | | | | | Yes | | | | | | | |
| 103 | | OPW | OPW Reports. South Galway, Clare River, Dunkellin | OPW | pdf | 1 | DSF | Reports on previous studies, supplied as part of tender. | Yes | | | | | Western | | | | | | Yes | | | | | | | |
| 104 | | OPW | Irish PFRA data and reports | OPW | Multiple | 1 | ? | | Yes | | | | | National | Yes | | | | | | | | | | | | |
| 105 | 18/08/2011 | Various | Development Boundary Data for various areas including Ballinrobe, Cavan, Dundalk, Louth, Meath, Monaghan | OPW | Mapinfo | 1 | SPW | | Yes | | | Project End | | Western | Yes | | | | | | | | | | | | |
| 106 | 30/08/2011 | EPA | Reports on 2009 Flooding including Claregalway, Croughwell, Gort, Loughrea and others | OPW | Word doc | 1 | SPW | | Yes | | | Project End | | Western | | | | | Yes | Yes | | | | | | | |
| 107 | 30/08/2011 | National Institute for Physical Planning | Inventory of Outstanding Landscapes in Ireland.pdf | OPW | pdf | 1 | SPW | | Yes | | | Project End | | Western | | | | | | | | | | | | Yes | |
| 108 | 30/08/2011 | OSI | Additional 5k mapping for data gaps in original data | OPW | tif | 1 | SPW | | Yes | | | Project End | | Neaghbann | Yes | | | | | | | | | | | | |
| 109 | 30/08/2011 | OPW | Neaghbann Floodmaps for the 2yr, 5yr, 10yr, 20yr, 50yr, 100yr and 200yr events | OPW | Shapefile | 3 | SPW | High level mapping outputs. Poor application at a property scale | Yes | | | Project End | | Neaghbann | Yes | Yes | | | | Yes | | | | | | | |
| 110 | 30/08/2011 | OPW | Northwest Floodmaps for the 2yr, 5yr, 10yr, 20yr, 50yr, 100yr and 200yr events | OPW | Shapefile | 3 | SPW | High level mapping outputs. Poor application at a property scale | Yes | | | Project End | | Northwest | Yes | Yes | | | | Yes | | | | | | | |
| 111 | 30/08/2011 | OPW | Letter of Introduction for FRR site visits | OPW | pdf | 1 | SPW | | N/A | | | | | | Yes | | | | | | | | | | | | |
| 112 | 06/09/2011 | Various | Receptor data for data gaps in original data including Bord Gais, ESB and Powerstation Assets. Also includes a dataset combining a number of assets. | OPW | Mapinfo | 1 | SPW | | Yes | | | Project End | | National | Yes | | | | | | | | | | | | |
| 113 | 08/09/2011 | GSI | GSI_re_rg_00000015441.pdf. List of Irish Turloughs. | Downloaded from OPW National Flood Hazard Mapping website by WS. | pdf | 1 | WS | PDF table obtained from the OPW flood hazard mapping website. Contains easting and northings and an accuracy flag. | N/A | | | None | Consult the website disclaimer on requirements and restrictions that may exist. | Western | | | | | | Yes | | | | | | | |
| 114 | 21/09/2011 | OPW | 2198_NWNB IE.TAB. North-West and Neaghbann Catchment Boundaries | Emailled from OPW | Mapinfo | 1 | JLC | Mapinfo TAB converted to Shapefile located in same location. | Yes | | | Project End | | Northwest and Neaghbann | Yes | | | | | | | | | | | | |
| 116 | 27/09/2011 | OPW | Grids of rainfall DDF model parameters and guidance on using them grid2smed.txt, 03 - DDF catchment Rainfall.ppt, 2202_DOC_OPW_110927.xls, ad4pgrid.txt grid | Emailled from OPW | | 1 | DSF | Used for rainfall analysis in inception. | Yes | | | Project End | | National | | | | | | | Yes | | | | | | |

| Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | | | | |
|--|---------------|--|---|--|--|---------------|---------------------------|---|----------------------------|--|----------------|---------------------|--|---|--|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data | Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | General comments |
| 117 | 04/10/2011 | OPW Floodmaps.ie & Galway City Council | Galway City Flood data_100810.doc | Email from Helen Coleman, Galway City Council, Helen.Coleman@galwaycity.ie | Word doc | 1 | | | N/A | | | | | Galway City | |
| 118 | 04/10/2011 | OPW | Water level data for Rossaveel (Ros a Mhí) and Big Bridge | Emailed from OPW | | 1 | DSF | Filling in gaps left over from earlier data requests. | Yes | | | Project End | | | |
| 115 | 20/09/2011 | OPW | 2202_REP_OPW_110919_SEA Screening report for CFRMPs | Emailed from OPW | Word doc | 1 | | SEA Screening Report. A copy of the Screening Report needs to be attached to any scoping notification re SEA as supporting evidence for the decision to proceed with SEA of the CFRMPs | N/A | | | | | National | Yes |
| 119 | 04/10/2011 | OPW/Met Eireann | More guidance on DDF model and R programs | Emailed from OPW | | 1 | DSF | Used for rainfall analysis in inception. | Yes | | | Project End | | National | |
| 120 | 06/10/2011 | Marine Institute | River level/flood data | Emailed from OPW | | 1 | DSF | We will probably not need this data. Most gauges were listed as "May not need this" on our data request. | Yes | | | Project End | Not to be used on other projects - requirement of Marine Institute. Need to acknowledge MI on any publications using this data. | | |
| 121 | 07/10/2011 | Galway CoCo | Minor works flood mitigation schemes | Sean Langhan (Galway CoCo) | | 1 | CNS | Minor works mitigation schemes put forward by Galway CoCo. Contains detail on number of property at risk etc. Mainly small schemes with few properties but some link in with our areas. | N/A | | | | | Yes | |
| 122 | 13/10/2011 | EPA and OPW | Remaining EPA hydrometric data and also Big Bridge gauge data (OPW) | Emailed from OPW | | 1 | DSF | Filling in gaps left over from earlier data requests. | Yes | | | Project End | | | |
| 123 | 19/10/2011 | OPW | Data licences Letter of commitment concerning the use of Data provided.doc, Letter of commitment concerning the use of Met Eireann Data.doc, Letter of commitment concerning the use of National Height Model.doc, SAFER022_SERTIT_Letter of Commitment - 100513.doc, Licence - Rev B.pdf | Emailed from OPW | Word documents | 1 | JLC | Updated licence agreements as originals referenced APS and the South Eastern CFRAM. These were overlooked by the DM for this reason! | N/A | | | | | Western | Yes |
| 124 | 20/10/2011 | NPWS | GIS files relevant to the distribution of Freshwater Pearl Mussel (Margaritifera margaritifera) and Nore Freshwater Pearl Mussel (Margaritifera durrovensis) in Ireland Margaritifera_Geodatabase.gdb, Margaritifera_GIS_resource catalogue.pdf, Margaritifera sensitive areas v02.msp.pdf | Emailed from OPW | File Geodatabase (MapInfo TAB supplied also) | 1 | JLC | Copies of the data in MapInfo TAB format are located in the subfolder named MapInfo. | Yes | Refer to highlighted text in: 'Data Management\Incoming Data\Client\2011.10.20 Fresh Water Pearl Mussel Data\Fresh Water Pearl Mussel_Instruction.pdf Review restrictions for the individual datasets in metadata document: 'Data Management\Incoming Data\Client\2011.10.20 Fresh Water Pearl Mussel Data\FPM Locations\Margaritifera_GIS_resource catalogue.pdf | | None | Digital or paper copies not to be distributed to the public. For the purposes of this project only. | National | Yes |
| 125 | 20/10/2011 | Sligo County Council | Hydraulic Study for Weir Rehab (containing hydrology for the Garageage) | Tom Kilfeather | pdf | 1 | SPW | Report from 1993 detailing hydrological and hydraulic analysis | N/A | | | | | Sligo | Yes |
| 126 | 19/11/2010 | Leltrim County Council | Flooding locations in Leltrim County for the purpose of the FRR | Brian Kenny | pdf | 1 | SPW | Hand drawn notes | N/A | | | | | Leltrim County | |
| 127 | 08/09/2011 | JBA | 2007s2586 - 2007 Post Flood Survey and Mapping Draft V1.0.pdf, EA AMS GRA Post Flood Data Collection.pdf, EA Post Flood data collection notes(Rob).pdf, Post Flood Survey Guidelines.doc, EA Flood Mapping Survey Brief.doc, West Flood Survey Work.doc. Includes emails from Ray Pickering advising use of documents. | Ray Pickering & Liz Russell | Various | 1 | JLC | Examples, guidance docs and risk assessments relating to flood monitoring, triggering and data collection plus various notes and emails. | N/A | | | | | n/a | Yes |
| 128 | 24/10/2011 | OPW / OSI | NW-NB missing tiles.zip | Emailed from OPW | .tif | 1 | JLC | Missing 50k mapping tiles covering the North West Neagh & Bann region | Yes | | | Project end | | Northwest and Neagh/Bann | Yes |
| 129 | 27/10/2011 | OPW | West.zip, 2202_DOC_OPW_111024_List of data to consultant.xls, West_2.shp, West_5.shp, West_10.shp, West_20.shp, West_50.shp, West_100.shp, West_200.shp, West_1000.shp These files supersede those delivered as part of the 2nd issue. | Downloaded from OPW data site | shapefile | 1 | JLC | Replacement coastal outlines that include missing data on the coast to the west of Galway city | Yes | | | Project end | Please note that this information is being issued for use on the Western CFRAM only and should not be issued to any third party without prior written approval from OPW. | Western | Yes |
| 130 | 27/10/2011 | OPW | South West.zip, 2202_DOC_OPW_111027b_List of data to consultant.xls, South_West_2.shp, South_West_5.shp, South_West_10.shp, South_West_20.shp, South_West_50.shp, South_West_100.shp, South_West_200.shp, South_West_1000.shp Coastal flooding extents covering the SW of the study area around Scanlans Island. | Downloaded from OPW data site | shapefile | 1 | JLC | Coastal flooding outlines supplied by OPW covering the extreme SW of the study area in the region of Scanlans Island. | Yes | | | | Please note that this information is being issued for use on the Western CFRAM only and should not be issued to any third party without prior written approval from OPW. | Western | Yes |
| 131 | 28/10/2011 | Leltrim County Council | Flooding locations in October 2011 - Glenfarne Area | Brian Kenny | pdf/jpg | 1 | SPW | | N/A | | | | | Leltrim County | |
| 132 | 10/11/2011 | EPA | EPA river network | ? | mapinfo tab | 1 | JLC | EPA river network supplied as part of the survey management contract contained more useful names for rivers, although the geometry is the same as the blue river network supplied under 2011s5232. SW requested that this be moved to warrington 10/11/2011 | Yes | | | Project end | A licence / permission to use the file has been requested from OPW on the 18/10/2011 but a response has yet to be received. JLC 10/11/2011 14:44:23 | National | Yes |
| 133 | 16/11/2011 | EPA | Flow data for New Bridge | Joseph McNamara | Text | 1 | DSF | Filling in gaps left over from earlier data requests. | Yes | | | Project end | | | |
| 134 | 22/11/2011 | EPA | CORINE 1990, 2000 (Revised), 2006, changes 1990-2000, changes 2000-2006, soils, subsoils and licensed waste facilities for relevant counties | Downloaded from EPA website | ESRI Shapefile | 1 | LH | | Yes | | | Project end | EPA confirmed ok to use data in email of 22/11/11 | Mayo, Sligo, Galway, Leltrim, Roscommon and Clare | Yes |
| 135 | 28/11/2011 | Geological Survey Ireland | Bedrock Geology 1:100,000 Groundwater Aquifers; Karst Features; Bedrock Geology 1:500,000 | Downloaded from GSI website | ESRI Shapefile | 1 | LH | | Yes | | | Project end | | | http://www.dcenr.gov.ie/Spatial+Data/Geological+Survey+of+Ireland/GSI+Spatial+Data+Downloads.htm |
| 136 | 28/11/2011 | Sligo County Council | Drainage route of culverted channel within Sligo | Donal Harrison | jpeg | 1 | SPW | | N/A | | | | | Sligo | |
| 137 | 25/11/2011 | OPW | Extra hydrometric data: rating report, gaugings, water level for Lough Corrib | Michael Duffy | csv | 1 | DSF | Filling in gaps left over from earlier data requests. | Yes | | | Project end | | | |
| 138 | 30/11/2011 | OPW | Information on ratings from FSU | Michael Duffy | Excel | 2 | DSF | | Yes | | | Project end | | | |
| 139 | 02/12/2011 | Sligo County Council | Photos of flooding nr Tubercurry on the 28/11/11 | Donal Harrison | jpg | 1 | SPW | | N/A | | | | | | |
| 140 | 04/12/2011 | Sligo County Council | Photos of the Owengarve bursting its banks | Donal Harrison | jpg | 1 | SPW | | N/A | | | | | | |
| 141 | 05/12/2011 | Leltrim County Council | Missing Figures from Landscape Character Assessment of Leltrim County | Paudge Keenaghan | jpg | 2 | LH | Resolution of figures is very low | N/A | | | | | Leltrim | Yes |
| 142 | 07/12/2011 | NOAA | World Vector Shoreline (WVS) data for Ireland | Download | txt | 3 | JLC | This dataset was extracted from the NOAA online database, as it is US government data it is (US) public data and therefore has no copyrights associated with it. Should be used for small-scale mapping only. | N/A | | | | | National | Yes |
| 143 | 26/10/2011 | Cavan CoCo | RE 2011s7275 CFRAM OCTOBER FLOODING.msg | AL email to ARB | jpeg | 1 | ARB | Email containing photos | N/A | | | | | Cavan | |
| 144 | 28/10/2011 | Donegal CoCo | Flooding at Murvagh.msg | DC email to ARB | .xls | 1 | ARB | Email containing screen grab of area prone to flooding | N/A | | | | | Donegal | Photos from CoCo Engineer |
| 145 | 07/11/2011 | Meath CoCo | Meath Chronicle report of flooding in Drumconrath | AH email to ARB | .doc | 2 | ARB | Newspaper article of local flooding | N/A | | | | | Meath | Screen-grab of area liable to flood in Murvagh |
| 146 | 31/08/2011 | Donegal CoCo | Rosstownagh Sewerage Scheme - First Draft - Report on surface water drainage and on the operation and maintenance of Dumes Lough outlet channel. 2006 | Received at meeting from Fergal Doherty | - | 2 | ARB | Report on area of high concern to CoCo but low relevance to CFRAM | N/A | | | | | Donegal | Local newspaper report |
| | | | | | | | | | | | | | | | Moved into storage |

| | | | | | | | | | | | | | | Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | | | |
|---------------------------|---------------|---|--|---|------------------------|---------------|---------------------------|--|----------------------------|--|----------------|---------------------|---|--|-----------------|---------------------|-------------|---------------|-----------------------|----------------------|-------|------------|------------|----------------------|--------------------|--|--|--|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data | Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | CIS / Core Data | OPW Spec / Guidance | Topo Survey | SEA / Nat Env | Flooding / Hydraulics | Hydromet / Hydrology | Comms | Econ / MCA | H&S / PSDP | Assets / Engineering | Coastal hydraulics | SEA - Spatial Planning / Human Env | General comments | |
| 147 | 06/09/2011 | Donegal CoCo | Letterkenny localised Flood Study - Oct 2002 | Received at Engineers meeting from Fergal Doherty | - | 1 | RS | 2002 Report for Letterkenny | N/A | | | | | Donegal | | | | | Yes | Yes | | | | | | | Moved into storage | |
| 148 | 06/09/2011 | Donegal CoCo | Letterkenny and Environs Development Plan Flood Study | Received at Engineers meeting from Fergal Doherty | - | 1 | RS | 2003 Development Plan - Flood Study | N/A | | | | | Donegal | | | | | Yes | Yes | | | | | | | Report to be stored | |
| 149 | 01/11/2011 | Media | Media search results for Oct 2011 flood event | JD collected info | .xls & .html | 1 | JD | Overview of Information.xls gives the breakdown | N/A | | | | | National | | | | | Yes | Yes | | | | | | | Various media reports of October flood event | |
| 150 | 19/10/2011 | ESB International | Preliminary Flood Risk Assessment of ESB Hydropower Infrastructure August 2011 | HD email to ARB | .pdf | 1 | ARB | PFRA Report on all ESB Infrastructure | N/A | | | | | National | | | | | Yes | Yes | | | | | | | | |
| 151 | 28/09/2011 | ESB International | Cathaleens Falls Generating Station Simulated Inundation Contours | HD email to ARB | .pdf | 1 | ARB | Mapping of breach model | N/A | | | | | Donegal | | | | | Yes | Yes | | | | | | | Mapping of Ballyshannon | |
| 152 | 09/09/2011 | Floodmaps.ie Various Co Co | Various reports and pictures downloaded from the Floodmaps.ie website for the FRR | Various | .pdf .jpeg | 1 | JD | Collated reports from floodmaps for each pre-site visit | N/A | | | | | Northwest, West, Neaghbann | | | | | Yes | Yes | | | | | | | Divided by county | |
| 153 | 28/09/2011 | Cavan Co Co | Various information from Cavan Co Co on flood event 20.11.09 - includes photographs , mapping and description of some photographs | PM to ARB | .doc .jpeg | 1 | ARB | Cavan Co Co record of event in Nov 2009 | N/A | | | | | Cavan | | | | | Yes | Yes | | | | | | | Flood event Nov 2009 | |
| 154 | 14/12/2011 | OPW | Extra hydrometric data including more AMAX and recent check gaugings | Peter Newport | csv | 1 | DSF | Filling in gaps left over from earlier data requests and updating after Nov 2011 floods. | Yes | | | Project end | | | | | | | | Yes | | | | | | | | |
| 155 | 16/12/2011 | EPA | Abstractions | Aisling McElwain | shapefile | 2 | LH | Abstractions. Collected in 2005. More up-to-date information may be available from local authorities. | Yes | N:\2011\Projects\2011s5232 - OPW - Western CFRAM - Overarching Project\Data Management\Incoming Data\Third Party\Environmental Protection Agency\Abstractions 16-12-2011 | | 12/13/16 | Use data only for purposes specified (i.e. Western CFRAM). Do not give access to or provide copies of the dataset to any third party, either in the format as provided by the Agency directly or as adapted by the organisation as part of any application. Do not sell the dataset, in whole or in part, nor will the dataset form part of any application or development, which is being sold | Western | Yes | | | Yes | | | | | | | Yes | | | |
| 156 | 19/12/2011 | Sligo County Council / CAAS Environmental Consultants Ltd | Sligo Scenic Evaluation Study | Donal Harrison | Word document and jpeg | 2 | LH | jpeg map is now out of date - most recent version of the map is in the (draft document) County Development Plan 2011-2017, Chapter 7, p. 117 (it's called Landscape Characterisation Map). | N/A | | | n/a | | Sligo | | | | yes | | | | | | | | yes | | |
| 157 | 09/12/2011 | Sligo County Council | Flooding at Tubercurry | Donal Harrison | jpeg | 1 | SPW | | N/A | | | | | Tubercurry | | | | | Yes | | | | | | | | | |
| 158 | 07/12/2011 | Alan Williams | Comments on survey specification for wave overtopping | Alan Williams | Word | 1 | SPW | | N/A | | | | | | | | Yes | | | | | | | | | | | |
| 159 | 22/12/2011 | OPW | Current water levels at various hydrometric gauging stations nationwide | kenneth freehill, email | Word | 1 | JLC | Regular river level updates provided by OPW. Single entry in the data register but may consist of several documents with ongoing updates. | Yes | | | Project end | | | | | | | Yes | Yes | | | | | | | | |
| 160 | 06/01/2012 | OPW | Flow data for Kilcolgan (strn. no. 29011) | Joseph McNamara email | Spreadsheet | 1 | JLC | Data checked to see that it opens only. JLC 10/01/2012 09:35:46 | Yes | I\Project Management\Document Control\Licences | | Project end | Restrictions apply for the distribution of data to third parties. See licence for details. | | | | | | Yes | Yes | | | | | | | | |
| 161 | 14/12/2011 | OPW | Updated LIDAR Map showing areas flown up to 1st Dec 2011 2328_REP_FBKS_111209_Prog Report 6_Flown.pdf | Joseph McNamara email | pdf | 1 | JLC | | N/A | | | | | | Yes | | Yes | | Yes | | | | | Yes | Yes | | | |
| 162 | 20/12/2011 | OPW? | List of AFAs Post Dec 11 PG Meeting West CFRAM - Provisional Final AFA Designations - Updated Post Meeting.xlsm | email | Spreadsheet | 1 | JLC | | Yes | | | Project end | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | |
| 163 | 16/01/2012 | OPW | Spreadsheets and notes on application of FSU methods | Joseph McNamara email | Mixed | 2 | DSF | For information only | Yes | | | Project end | | | | | | | | Yes | | | | | | | | |
| 164 | 21/09/2011 | OSI | Small scale OSI basemapping. 1:210k & 1:450k mapping Mapping.zip | Ger Cafferkey OPW | *.tif | 1 | JLC | 1:210k and 1:450k basemapping | Yes | I\Data Management\Incoming Data\Client\2011.09.21 Reports and mapping\AL2_ScheduleD_Contractors_and_Subcontractors_Form[1]-1_JBASigned.pdf | | End of project | | | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | | |
| 165 | 21/09/2011 | OPW | OPW flood reports for Clare River, Dunkellin, South Galway, scanned from Trim HQ and various others. | Ger Cafferkey OPW | *.pdf | 1 | JLC | | Yes | | | Project end | | | | | Yes | Yes | Yes | Yes | | | | Yes | Yes | Yes | | |
| 166 | 21/09/2011 | OPW | Synoptic Stations. Hourly rainfall data for Clones, Birr and Shannon Airport | Ger Cafferkey OPW | data file | 1 | JLC | | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | | End of project | | | | | | | Yes | Yes | | | | | | | | |
| 167 | 24/01/2012 | Jacobs | Hydrology course training materials (for Shannon) | Iain Blackwell, Jacobs by email | *.ppt | 2 | DSF | DSF has checked and will incorporate suitable parts into our course. | Yes | | | Project end | | | | | | | | Yes | | | | | | | Exercises provided by email on 25/01/12 | |
| 168 | 24/01/2012 | OPW | Staff gauge data from OPW Staff Gauge HA 29.zip, Staff Gauge HA 30.zip, Staff Gauge HA 31.zip, Staff Gauge Only HA32.zip, Staff Gauge Only HA34.zip, Staff Gauge Only HA35.zip | Richard Duffy / email | zipped data files | 1 | JLC | A sample of data opened to check viability of the files | Yes | Letter of commitment concerning the use of Data provided.doc_JBA_Signed.pdf | | End of project | | | | | | | Yes | Yes | | | | | | | | |
| 169 | 03/02/2012 | OPW | Feasibility study report for Crossmolina | Joseph McNamara email | PDF | 1 | DSF | Relevant to rating review. | Yes | | | Project end | | | | | | | | Yes | | | | | | | | |
| 170 | 05/03/2012 | OPW | progress update reports | Joseph McNamara email | PDF | 1 | SPW | | Yes | | | Project end | | | | | Yes | | | | | | | | | | | |
| 171 | 01/03/2012 | OPW | Flown lidar progress report | Joseph McNamara email | *.ods (spreadsheet) | 1 | | | Yes | | | Project end | | | Yes | | Yes | | Yes | Yes | | | | Yes | Yes | | | |
| 172 | 09/12/2011 | OPW | Groundwater Study Information | Richard Duffy / email | doc, pdf | 1 | | Minutes and presentations from meeting. | Yes | | | Project end | | | | | | | Yes | Yes | | | | | | | | |
| 173 | 27/03/2012 | OPW | LIDAR progress report no 2 | Richard Duffy / email | *.xls | 1 | JLC | | Yes | | | Project end | | | | | Yes | | Yes | Yes | | | | Yes | Yes | | | |
| 174 | 05/03/2012 | OPW | Survey information for inclusion on Western website | Joseph McNamara / email | *.doc | 1 | JLC / ER | | Yes | | | Project end | | | | | | | | | Yes | | | | | | | |
| 175 | 23/11/2011 | Galway City Council | List of minor works and PG3 feedback | Billy Dunne / Letter | PDF | 2 | JLC | Scan of letter received from GCC. Little details regarding minor works. | N/A | | | | | | | | | | | | Yes | | | Yes | | | | |
| 176 | 06/12/2011 | OPW | List of Minor works schemes for 2009, 2010 and 2011 2202_DOC_OPW_111206_List of data to consultant.xls 2202_DOC_OPW_111206_List of Funding Allocations Coastal & Non Coastal 2009.xls 2202_REP_OPW_111106_COMPLETE Coastal Non Coastal Approved Projects 2010.doc 2202_REP_OPW_111206_Minor Works 2011 allocation list.doc | Richard Duffy / email | *.xls, *.doc | 1 | JLC | Summary information of minor works received from OPW. Contains good detail and concise information. | Yes | | | Project end | | | | | | | | | | Yes | | | Yes | | | |
| 178 | 21/04/2012 | OPW | Tender Doc for the Guaging Station Survey - Murphy Surveys | Christine McCann, Courier | *.doc | 1 | MON | | N/A | | | | | | | | Yes | | | | | | | | | | | |
| 179 | 21/04/2012 | OPW | Tender Doc for the Guaging Station Survey - CCS | Christine McCann, Courier | *.doc and *.pdf | 1 | MON | | N/A | | | | | | | | Yes | | | | | | | | | | | |
| 180 | 21/04/2012 | OPW | Tender Doc for the Guaging Station Survey - Maltby | Christine McCann, Courier | *.doc and *.pdf | 1 | MON | | N/A | | | | | | | | Yes | | | | | | | | | | | |
| 181 | 27/04/2012 | OPW | Sites vulnerable to Wave Overtopping | Richard Duffy / email | pdf and shp | 1 | SPW | | Yes | | | Project end | Please note that this information should not be passed on to any third party or used for any purpose other than the Western CFRAM Study without prior written consent from the OPW | | | | | | Yes | | | | | | Yes | Please note that this information should not be passed on to any third party or used for any purpose other than the Western CFRAM Study without prior written consent from the OPW | | |
| 182 | 27/04/2012 | OPW | LIDAR sample at Tuam | Ger Cafferkey OPW via OPW fileshare | various | 4 | CNS | This is only a sample so low quality score. Will be replaced by a final deliverable later. | Yes | | | Project end | | | | | Yes | | | | | | | | | | | |

| | | | | | | | | | | | | | | | Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | | |
|---------------------------|---------------|--|---|-----------------------|---------------------|---------------|---------------------------|---|----------------------------|-----------------------|----------------|---------------------|---|--|--|---------------------|-------------|---------------|-----------------------|--------------------------|-------|------------|------------|----------------------|--------------------|------------------------------------|------------------|---|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data | Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | CIS / Core Data | OPW/ Spec/ Guidance | Topo Survey | SEA / Nat Env | Flooding / Hydraulics | Hydrometrics / Hydrology | Comms | Econ / MCA | H&S / PSDP | Assets / Engineering | Coastal hydraulics | SEA - Spatial Planning / Human Env | General comments | |
| 183 | 27/04/2012 | OPW | Detailed ICWWS Output for Tralee Bay | Richael Duffy / email | | N/A | KK | Example / sample data - no quality score needed | Yes | | | Project end | This information should not be passed on to any third party, or used for any other purpose other than CFRAM Study, without our prior written consent. | | | | | | Yes | | | | | | Yes | | | |
| 184 | 02/05/2012 | Sligo County Council | Sligo County Council EPA Hydrometric Review | Donal Harrison | | 1 | SPW | | Yes | | | | | | | | | | | Yes | | | | | | | | |
| 185 | 10/05/2012 | OPW | Irish Material for Western CFRAM Website | Peter Duffy / email | | N/A | JLC | Website text, no quality score required. | N/A | n/a | | n/a | n/a | n/a | | | | | | | Yes | | | | | | | Irish translation of CFRAM description to be linked from the main page of the Western CFRAM website. |
| 186 | 23/11/2011 | Central statistics Office Ireland | Population and Actual and Percentage Change 2006 and 2011 by Sex | Internet download | Excel | 2 | LH | 2011 figures are preliminary only | N/A | n/a | | n/a | n/a | Western | | | | | | | | | | | | yes | | http://census.cso.ie/census/ReportFolders/ReportFolders.aspx?CS_referer=&CS_ChosenLang=en |
| 187 | 19/12/2011 | The Department of Communications, Energy and Natural Resources | National Report for Ireland on Eel Stock Recovery Plan (Including River Basin District Eel Management Plans) | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | yes | | | | | | | | | | http://www.dcenr.gov.ie/NR/rdonlyres/85E7B93C-9E85-4E81-8848-CAB42E1037BC/0/NationalManagementPlan191208v.pdf |
| 188 | 14/09/2011 | WRFB and NWRFB | Western River Basin District Eel Management Plan | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Western | | | | | yes | | | | | | | | | http://www.dcenr.gov.ie/NR/rdonlyres/1A1CFE18-5A7E-4441-A13F-DB98B1F5988F/0/WRBD191208.pdf |
| 189 | 21/12/2011 | Department for Agriculture, food and the marine | Forestry Service Documents (Code of Best Forest Practice, Afforestation Scheme, Native Woodland Scheme – Establishment, Forestry Environment Protection (Afforestation) Scheme) | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | | yes | | | | | | | | | http://www.agriculture.gov.ie/forestservice/grantandpremiumschemes/ |
| 190 | 02/12/2011 | Department of Environment, Community and Local Government | Freshwater Pearl Mussel Sub-Basin Management Plans (Owenviff, Bundorrigha, Dawros and Newport) and SEA Scoping Report, Literature Review and Environmental Report | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Bundorrigha, Dawros, Newport and Owenviff sub-basins / Ireland for SEA reports | | | | | yes | | | | | | | | | http://www.wfdireland.ie/docs/5_FreshwaterPearlMusselPlans/ |
| 191 | 26/09/2011 | Sligo County Council | Sligo County Record of Protected Structures | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Sligo | | | | | | | | | | | | yes | | http://www.sligococo.ie/Services/Planning/DevelopmentPlans/County/ |
| 192 | 26/09/2011 | Galway County Council | Galway County Record of Protected Structures | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Galway County | | | | | | | | | | | | Yes | | http://www.galway.ie/en/Services/Conservation/RecordofProtectedStructures/ |
| 193 | 25/11/2011 | Galway City Council | Galway City Record of Protected Structures | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Galway City | | | | | | | | | | | | Yes | | http://www.galwaycity.ie/AllServices/Planning/Publications/#d.en.607 |
| 194 | 26/09/2011 | Mayo County Council | List of Structures on the Record of Protected Structures for County Mayo | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Mayo | | | | | | | | | | | | Yes | | http://www.mayococo.ie/en/Planning/DevelopmentPlansandLocalAreaPlans/MayoCountyDevelopmentPlan2008-2014/PDFFile/7800.en.pdf |
| 195 | 26/09/2011 | Roscommon County Council | Record of Protected Structures County Roscommon and additional structures | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Roscommon | | | | | | | | | | | | Yes | | http://www.roscommoncoco.ie/en/Services/Heritage/Record_of_Protected_Structures/ |
| 196 | 24/01/2012 | Environmental Resources Management / Clare County Council | Landscape Character Assessment of Co. Clare (including seascapes) | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Clare | | | | | | | | | | | | Yes | | http://www.heritagecouncil.ie/landscapes/publications/landscape-character-assessment-of-co-clare/ |
| 197 | 26/09/2011 | CAAS Environmental Consultants / Mayo County Council | Landscape Appraisal of County Mayo | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Mayo | | | | | | | | | | | | yes | | http://www.mayococo.ie/en/Planning/DevelopmentPlansandLocalAreaPlans/MayoCountyDevelopmentPlan2008-2014/PDFFile/7799.en.pdf |
| 198 | 26/09/2011 | Roscommon County Council | LANDSCAPE CHARACTER ASSESSMENT OF COUNTY ROSCOMMON | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Roscommon | | | | | | | | | | | | Yes | | http://www.roscommoncoco.ie/en/Services/Planning/County_Development_Plan_2008-2014_and_Variations/Landscape_Character_Assessment/ |
| 199 | 15/05/2012 | Leitrim County Council / Environmental Resources Management | Landscape Assessment Of County Leitrim | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Leitrim | | | | | | | | | | | | Yes | | http://www.leitrimcoco.ie/eng/Services_A-Z/Planning_and_Building_Control/Publications/Landscape_Character_Assessment_of_Co_Leitrim.pdf |
| 200 | 26/09/2011 | Galway County Council | Galway County Council County Development Plan 2009 –2015 (including Appropriate Assessment, Natura Impact Statement, SEA Scoping Report, SEA Environmental Report, SEA Non-Tech Summary, SEA Statement) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Galway | | | | Yes | | | | | | | | Yes | | http://www.galway.ie/en/Services/Planning/DevelopmentPlans/GalwayCountyDevelopmentPlan2009-2015/CountyDevelopmentPlan2009-2015/ |
| 201 | 26/09/2011 | Galway City Council | Galway City Council Development Plan 2011-2017 (including Appropriate Assessment, Map, SEA Environmental Report) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Galway City | | | | Yes | | | | | | | | Yes | | http://www.galwaycity.ie/AllServices/Planning/DevelopmentPlanandPolicySection/GalwayCityDevelopmentPlan20112017/ |
| 202 | 26/09/2011 | Leitrim County Council | Leitrim County Development Plan 2009-2015 (Including SEA Environmental Report, SEA Statement, Maps) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Leitrim | | | | Yes | | | | | | | | Yes | | http://www.leitrimcoco.ie/eng/News/Leitrim_County_Development_Plan_2009-2015.html |
| 203 | 26/09/2011 | Mayo County Council | Mayo County Development Plan 2008-2014 (Incorporating Variation No. 1 made on the 11th November 2009) (including SEA Environmental Report, SEA Non-tech Summary, SEA Statement) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Mayo | | | | Yes | | | | | | | | Yes | | http://www.mayococo.ie/en/Planning/DevelopmentPlansandLocalAreaPlans/MayoCountyDevelopmentPlan2008-2014/ |
| 204 | 26/09/2011 | Roscommon County Council | Roscommon County Council - Adopted County Development Plan Files (including amendments, SEA Statement, SEA Environmental Report) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Roscommon | | | | Yes | | | | | | | | Yes | | http://www.roscommoncoco.ie/en/Services/Planning/County_Development_Plan_2008-2014_and_Variations/County_Development_Plan/Adopted_County_Development_Plan/ |
| 205 | 26/09/2011 | Sligo County Council | Sligo and Environs Development Plan 2010-2016 (including SEA Environmental Report, SEA Statement, SEA Non-tech Summary) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Sligo | | | | Yes | | | | | | | | Yes | | http://www.sligococo.ie/sedp/ |
| 206 | 16/05/2012 | Clare County Council | Clare County Development Plan 2011–2017 (Including SEA Environmental Report, SEA Habitats Regulations Assessment, SEA Statement) | Internet download | pdf | 1 | LH | Variations and updates to development plan may be made periodically by council - documents may need to be updated | N/A | n/a | | n/a | n/a | Clare | | | | Yes | | | | | | | | Yes | | http://www.clarecoco.ie/planning/plans/clare-county-development-plan-2011-2017/ |
| 207 | 26/03/2012 | West Regional Authority | Draft Regional Planning Guidelines for the West Region 2010 – 2022: Draft Environmental Report | Internet download | pdf | 2 | LH | Currently only draft plan | N/A | n/a | | n/a | n/a | Western | | | | Yes | | | | | | | | Yes | | http://www.galway.ie/en/Business/WestRegionalAuthority/RegionalPlanningGuidelines20102022/ |
| 208 | 06/12/2011 | Clare Biodiversity Group | Clare Biodiversity Action Plan | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Clare | | | | Yes | | | | | | | | | | http://www.aughy.org/pdf/ClareBiodivActionPlan.pdf |
| 209 | 06/12/2011 | Heritage Council and Sligo County Council Heritage Office | County Sligo Draft Biodiversity Action Plan | Internet download | pdf | 2 | LH | Currently only draft plan | N/A | n/a | | n/a | n/a | Sligo | | | | Yes | | | | | | | | | | http://www.sligococo.ie/News/Name.19204.en.html |
| 210 | 06/12/2011 | Galway County Council | BIODIVERSITY ACTION PLAN for County Galway 2008 - 2013 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Galway | | | | Yes | | | | | | | | | | http://www.galway.ie/en/Services/Heritage/BiodiversityProject/ActionPlan/ |
| 211 | 06/12/2011 | Mayo County Council | Draft County Mayo Biodiversity Action Plan 2010 - 2015 | Internet download | pdf | 2 | LH | Currently only draft plan | N/A | n/a | | n/a | n/a | Mayo | | | | Yes | | | | | | | | | | http://www.mayococo.ie/en/media/Media.12650.en.pdf |
| 212 | 06/12/2011 | Roscommon County Council | Draft County Roscommon Biodiversity Action Plan and Draft County Roscommon Heritage Plan 2012-2016 Incorporating County Roscommon Biodiversity Action Plan | Internet download | pdf | 2 | LH | Currently only draft plan | N/A | n/a | | n/a | n/a | Roscommon | | | | Yes | | | | | | | | | | http://www.heritagecouncil.ie/fileadmin/user_upload/heritageplans/Roscommon/Roscommon_Draft_County_Heritage_Plan_2012-2016.pdf |

| | | | | | | | | | | | | | | | Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | | |
|---------------------------|---------------|--|--|---------------------------------|---------------------|---------------|---------------------------|---|----------------------------|---|----------------|---------------------|--|---------------------------|--|---------------------|-------------|---------------|-----------------------|---------------------------|-------|------------|------------|-----------------------|---------------------|------------------------------------|---|--|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data | Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | CIS / Core Data | OPW Spec / Guidance | Topo Survey | SEA / Nat Env | Flooding / Hydraulics | Hydrometr ics / Hydrology | Comms | Econ / MCA | H&S / PSDP | Assets / Engineer ing | Coastal hydraulic s | SEA - Spatial Planning / Human Env | General comments | |
| 213 | 06/12/2011 | Department of Arts, Heritage and the Gaeltacht | ACTIONS FOR BIODIVERSITY 2011-2016: IRELAND'S NATIONAL BIODIVERSITY PLAN | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.ahg.gov.ie/en/Publications/HeritagePublications/NatureConservationPublications/Actions%20for%20Biodiversity%202011%20-%202016.pdf | |
| 214 | 16/05/2011 | Department of Environment, Community and Local Government | National Spatial Strategy for Ireland 2002 - 2020 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | Yes | | | Yes | | http://www.irishspatialstrategy.ie/ | |
| 215 | 30/08/2011 | NPWS | Conservation objectives, site synopsis and Natura 2000 data forms for SACs and SPAs in RBD. Information on OSPAR sites and Wildfowl Sanctuaries | Internet download | pdf, Excel | 1 | LH | | N/A | n/a | | n/a | n/a | Western | | | | Yes | | | | | | | | | http://www.npws.ie/ | |
| 216 | 22/11/2011 | Department of Agriculture, Fisheries and Food | Ireland Rural Development Programme 2007-2013 Summary of Measures and CAP Rural Development Programme 2007-2013 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | Yes | | | Yes | | http://www.enviromen.ie/en/Publications/Community/RuralDevelopment/FileDownload.26522.en.pdf | |
| 217 | 10/11/2011 | Faite Ireland | FÁILTE IRELAND WEST and NORTH WEST: Regional Tourism Development Plan 2008-2010 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Western and North-western | | | | Yes | | | | Yes | | | Yes | | http://www.faitaireland.ie/Word_files/about_us/Faite-Ireland-West-Regional-Tourism-Development-P | |
| 218 | 14/09/2011 | West River Basin District | Western River Basin Management Plan (including Programme of Measures, SEA, Appendices 4 and 5) | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Western | | | | Yes | Yes | Yes | Yes | Yes | | | Yes | Yes | http://www.wrbd.ie/ | |
| 219 | 19/12/2011 | Invasive species Ireland | Lagarosiphon major Lough Corrib- An Aggressive Invasive Species in Lough Corrib | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Lough Corrib | | | | Yes | | | | | | | | | http://invasivespeciesireland.com/wp-content/uploads/2010/11/Case_Study_2_Lagarosiphon_major_Lough_Corrib.pdf | |
| 220 | 19/12/2011 | Mayo County Council | Invasive Alien Plant: Giant Rhubarb | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Mayo | | | | Yes | | | | | | | | | http://www.mayococo.ie/en/Services/Heritage/GunneratinctoriaGiantRhubarb/File.8428.en.pdf | |
| 221 | 06/12/2011 | Environment & Heritage Service and National Parks & Wildlife Service | INVASIVE SPECIES IN IRELAND | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.botanicgardens.ie/gspc/pdfs/quercusreport.pdf | |
| 222 | 20/09/2011 | | IRELAND National Development Plan 2007-2013 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | Yes | | http://www2.ul.ie/pdf/932500843.pdf | |
| 223 | 21/11/2011 | Department of Agriculture, Fisheries and Food | Farmers Handbook for REPS4 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | Yes | | http://www.agriculture.gov.ie/media/migration/farmingschemesandpayments/ruralenvironmentprotectionschemereps/latestreps4FamersHandbook_LowRes.pdf | |
| 224 | 21/11/2011 | Department of Agriculture, Fisheries and Food | Specifications for the Agri-Environment Options Scheme and Natura 2000 Scheme and circular | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | Yes | | http://www.agriculture.gov.ie/farmerschemespayments/ruralenvironmentprotectionschemereps/repandaeoschemes/agri-environmentoptionschemeaeos/ | |
| 225 | 31/10/2011 | EPA | Ireland's Environment 2008 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | Yes | | http://www.epa.ie/downloads/pubs/other/indicators/irlenv/ | |
| 226 | 31/10/2011 | EPA | TOWARDS SETTING ENVIRONMENTAL QUALITY OBJECTIVES FOR SOIL. DEVELOPING A SOIL PROTECTION STRATEGY FOR IRELAND | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.epa.ie/downloads/pubs/land/name_13039_en.html | |
| 227 | 31/10/2011 | EPA | Ireland's Environment 2004 | Internet download | pdf | 2 | LH | report superseded by 2008 report | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.epa.ie/downloads/pubs/other/indicators/soe2004/ | |
| 228 | 31/10/2011 | EPA | Submission in accordance with Article 5 of Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, and in accordance with EC-DG Environment D.2 document "Reporting Sheets for 2005 Reporting" dated 19 November 2004. | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.wfdireland.ie/Documents/Characterisation%20Report/IE_Compiled_Article5_Risk_Sheets_v2.pdf | |
| 229 | 14/12/2011 | Inland Fisheries Ireland | Wild Salmon and Sea Trout Statistics Report 2010 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.fishinginireland.info/pdf/WildSalmonSeaTroutStatisticsReport2010.pdf | |
| 230 | 12/12/2011 | Inland Fisheries Ireland | Inland Fisheries Ireland Inaugural Report | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.fisheriesireland.ie/Corporate/corporate-publications.html | |
| 231 | 21/11/2011 | Faite Ireland | FEASIBILITY STUDY TO IDENTIFY SCENIC LANDSCAPES IN IRELAND | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.faitaireland.ie/Word_files/about_us/Feasibility-Study-To-Identify-Scenic-Landscapes-In | |
| 232 | 28/11/2011 | Heritage Council | Proposals for Ireland's Landscape 2010 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | Yes | | http://www.heritagecouncil.ie/fileadmin/user_upload/Publications/Landscape/Proposals_for_Irelands_Landscapes_main.pdf | |
| 233 | 09/12/2011 | Teagasc | Teagasc-EPA Soils and Subsoils Mapping Project | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | | | http://www.teagasc.ie/news/2010/201003-02.asp | |
| 234 | 31/10/2011 | EPA | WATER QUALITY IN IRELAND 2007-2009 | Internet download | pdf | 1 | LH | | N/A | n/a | | n/a | n/a | Ireland | | | | Yes | | | | | | | Yes | | http://www.epa.ie/downloads/pubs/water/waterqua/name_30640.en.html | |
| 235 | 29/05/2012 | NPWS | Special Protection Areas, Proposed Natural Heritage Areas, Natural Heritage Areas & Special Area of Conservation. Feature Classes downloaded in file geodatabase format from the NPWS Map Viewer: http://webgis.npws.ie/npwsviewer/ | Internet download | file geodatabase | 1 | JLC | | Yes | http://www.npws.ie/datapolicy/ | | n/a | Data are provided on the understanding that users will: respect the policy of NPWS on restrictions of access to sensitive data. acknowledge NPWS as the originators of the records in all uses of these data. provide NPWS, upon request, with copies of any reports or publications resulting from the use of these data. not use the information to the detriment of individual species or habitats, biodiversity or the environment in general. | National | Yes | | | Yes | | | | | | | Yes | | | |
| 236 | 28/11/2012 | Mayp CoCo | List of flooding incidents | email / David Mellett Mayo CoCo | pdf / email | 2 | JLC | Downloaded as ING projection | N/A | | | | | | | | | | | Yes | Yes | | | Yes | | | | |
| 237 | 06/06/2012 | OPW | Lidar Progress Report - 6th June 2012 | Ger Cafferky, OPW | pdf / email / excel | 1 | MON | List of flooding locations and descriptions. Little detail of problem and poor location resolution | N/A | | | | | Western | | | | Yes | | Yes | | | | | Yes | | | |
| 238 | 16/05/2012 | Sligo Co Co | Ballyhidrid Tidal Flap Photos | Gary Saller Sligo Co Co | jpg | 1 | SPW | | | | | | | Ballysadare | | | | | Yes | | | | | | | | | |
| 239 | 16/05/2012 | Sligo Co Co | Carrowgobbadagh Tidal Flap Photos | Gary Saller Sligo Co Co | jpg | 1 | SPW | | | | | | | Ballysadare | | | | | Yes | | | | | | | | | |
| 240 | 02/05/2012 | Sligo Co Co | Sligo -EPA Hydrometric Review | Donal Harrison Sligo Co Co | excel | 1 | SPW | | | | | | | Sligo County | | | | | | Yes | | | | | | | | |
| 241 | 15/06/2012 | OPW | National CFRAM Comms Strategy Rev 0.4 | Mark Adamson | word | 2 | SPW | | | | | | | All | | | | | | | Yes | | | | | | | |
| 242 | 08/06/2012 | OPW | Water Levels on the Suck River in June 2012 | Kenneth Freehill | word | 1 | SPW | | | | | | | N/A | | | | | | | | | | | | | | |
| 242b | 08/06/2012 | OPW | Significant Water Levels. | Peter Newport | excel | 1 | ? | Received from OPW. Assumed to be best data available. | Yes | | | End of project | | | | | | | | | | | | | | | | |
| 243 | 25/06/2012 | OPW | NTCG Presentations from the 18th and 19th June | Riaghal Duffy | pdf | | | Presentations no data quality required. | | | | | | All | | Yes | Yes | | | Yes | | | | | | | | |
| 244 | 06/06/2012 | OPW | PFRA submissions for West RBD | Peter Duffy | zip | 1 | CNS | PFRA submissions as they are. | | | | | | | | Yes | | | | | | | | | | | | |
| 245 | 25/06/2012 | Galway County Council | Road flooding maps | Sean Langan | pdf, mapinfo | 1 | LH | | | | | | | Galway County | | | | | | | | Yes | | Yes | | Yes | | |
| 246 | 07/08/2012 | OPW | Spreadsheets to help with applying FSU methods | Oliver Nicholson | Excel | 2 | DSF | The pooling spreadsheet is for internal OPW testing, interpretation and training. It is subject to ongoing development and correction in-house and should be used with caution. | | | | | | | | | | | | Yes | | | | | | | | |
| 247 | 07/08/2012 | OPW | Technical notes on catchment boundaries for Shannon CFRAM | John Martin | word | 1 | DSF | Useful background information on how FSU catchment boundaries were derived and why they may differ from other sources of information. | | | | | | | | | | | | Yes | | | | | | | | |

| | | | | | | | | | | | | | | | Subjects Areas - enter 'Yes' as appropriate from dropdown. Tech Leads, Assist PM or PM to complete | | | | | | | | | | | | |
|---------------------------|---------------|--|--|--|----------------------------|---------------|---------------------------|--|----------------------------|-----------------------|----------------|---------------------|------------------------|-----------------|--|---------------------|-------------|---------------|-----------------------|-------------------------|-------|------------|------------|----------------------|--------------------|------------------------------------|---|
| Register Reference Number | Date Received | Original Owner | Data Name | Sent by who / how | Media Type / Format | Quality (DQS) | JBA data owner / reviewer | Quality comment by JBA or data owner - describe the quality, relevance, fitness-for-purpose and appropriate use (or otherwise) of data. | Licensed to JBA (Yes / No) | Licence X-Ref to Data | Licences Sheet | Licence Expiry Date | Key licence conditions | Areas Concerned | GIS / Core Data | OPW Spec / Guidance | Topo Survey | SEA / Nat Env | Flooding / Hydraulics | Hydrometris / Hydrology | Comms | Econ / MCA | H&S / PSDP | Assets / Engineering | Coastal hydraulics | SEA - Spatial Planning / Human Env | General comments |
| 248 | 21/07/2012 | RBD Project | River Basin Management Plans 2009 - 2015 including Key supporting documents for River Basin Districts in Ireland | Given to Jonathan Cooper at SEA workshop | pdf | 1 | UoM Managers and LH | | | | | | | ALL | | | | | | | | | | | | | |
| 249 | 20/08/2012 | Department of Communications, Marine and Natural Resources | Scoping Study to assess the status of Irelands tide gauge infrastructure and outline current and future requirements | Richael Duffy | pdf | 1 | SPW | Report will be superseded but provides an up to date reference for all tidal gauges at the time of writing | | | | | | Tidal | | | | | | | | | | | Yes | | |
| 250 | 25/07/2012 | Sligo Co Co | Feedback from local engineers of recent flooding in Sligo | Donal Harrison Sligo Co Co | email | 1 | SPW | Bulk of data relates to surface water flooding so is of little relevance to this study | | | | | | Sligo | | | | | Yes | Yes | | | | | | | |
| 251 | 01/08/2012 | Sligo Co Co | Draft development plan for Tobercurry | donal Harrison Sligo Co Co | dwg | 2 | SPW | This is a draft development plan and is not for external use. The plan is currently being updated by Sligo Co Co | | | | | | Tobercurry | Yes | | | | | | | | | | | | |
| 252 | 21/08/2012 | OPW | Housing estate in Athenry | Rosmarie Lawlor | pdf | 1 | | Data provided for information only to determine final project watercourses | | | | | | Athenry | | | | | Yes | | | | | | | Yes | |
| 253 | 21/08/2012 | Sligo Co Co | Feedback from local engineers of recent flooding in Sligo | John Morris | email | 1 | SPW | Flooding highlighted at Coolaney and Cloonacol | | | | | | Coolaney | | | | | Yes | | | | | | | | |
| 254 | 28/08/2012 | OPW | Feedback on comments responses for Inception Reports UoM 31-35 | Richael Duffy | word | 1 | SPW | | | | | | | | | | | | | | | | | | | | |
| 255 | 30/07/2012 | OPW | Lidar Data - Castlebar, Corrofin, Westport, Louisburgh, Foxford, Ballyhaunis, Tuam, Oughterard, Loughrea, Claregalway. | Rosemarie lawlor | | 1 | JLC | Fisrt draft of lidar without ESRI files as requested | | | | | | Various | Yes | | Yes | | | | | | | | | | May be superseded when format is fully agreed with OPW. |
| 256 | 28/08/2012 | Met Eireann | Additional daily rainfall gauged data from Met Eireann, covering 1 Jan 2010 - 31 May 2012 | Rosemarie lawlor | file | 1 | JLC | Received from OPW. JLC has not looked at the data itself. Assumed to be of a good enough quality to use. Have informed DF of its location. | Yes | | | | | Western | | | | | Yes | Yes | | | | | | | |
| 257 | 28/08/2012 | OPW | Sample Lidar data for review covering Westport in IMG and ESRI ASCII formats with both ING and ITM projections. | Rosemarie lawlor | IMG and ESRI ASCII formats | 2 | JLC | To be superseded with revised format | Yes | | | | | Westport | Yes | | Yes | | Yes | Yes | | | | | | | |
| 258 | 28/08/2012 | Malby | Western Gauging Station Survey Contract (WSC1) - WP1 draft deliverables | Richard Malby | | 2 | MON | Draft data, elements to be superseded, good quality | | | | | | | | | | | | | | | | | | | |
| 259 | 29/08/2012 | OPW | Flown lidar progress report | OPW Rosemarie Lawlor | | | JLC | Textual report | | | | | | Western | Yes | | Yes | | | | | | | | | | |

B.1 Rating review - Billa Bridge

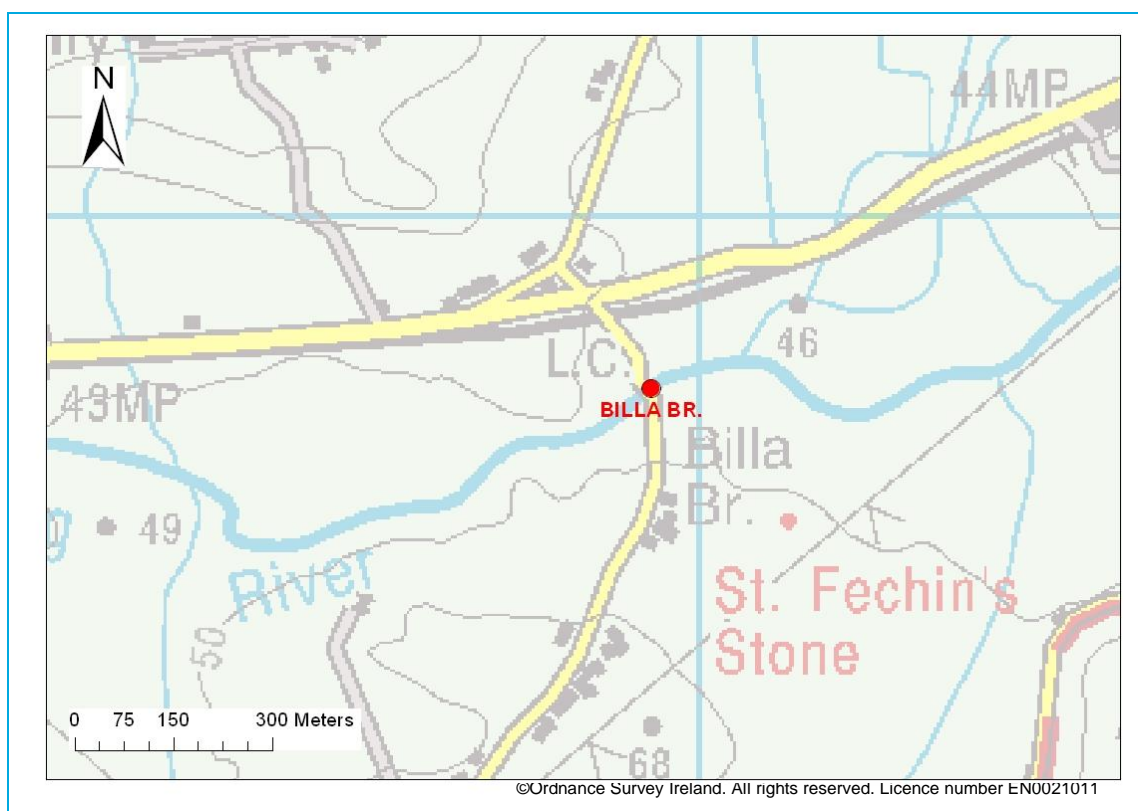
B.1.1 Station description

B.1.1.1 Gauge summary

| | | | |
|-----------------------|---------------|--------------------|---------------|
| Station name | Billa Bridge | Site type | Velocity-area |
| Station number | 35002 | Watercourse | Owenbeg River |
| Grid reference | 163926 325739 | Operator | OPW |

B.1.1.2 Location

The bridge is located immediately upstream of the bridge on the right bank.



B.1.1.3 Gauge Datum


| | |
|--|--|
| Gauge datum (mAOD) | 46.90 |
| Means of confirmation (e.g. survey) | Not known |
| Other comments (e.g. gauge boards) | <p>A total of 5 datum elevations have been supplied for the gauge with the most recent being valid from 1985.</p> <p>There are two gauge boards, one mounted to the left bank bridge abutment and the other to the right bank abutment. Both appear to be at the same elevation.</p> |

B.1.1.4 Description / other comments

The gauge is located immediately upstream of the bridge on the right bank. Upstream of the gauge the river meanders slightly, passing through a natural constriction of slightly higher ground. After this, the floodplains broaden again, particularly on the left bank. Downstream of

the bridge the river passes some minor riffles and enters a broad leftward meander. The floodplains remain broad on both banks.

B.1.1.5 Control on stage discharge relationship

| | |
|-----------------------------|---|
| Type of section | Bridge |
| Low flow control(s) | <p>The dominant controls on the stage discharge relationship at low flows are likely to be the natural channel geometry (and that at the base of the bridge). There is no formal control structure and supercritical flow is not present immediately downstream thus influences from downstream hydraulic controls are also possible.</p>  |
| High flow control(s) | <p>It is likely that the hydraulic influence of the bridge will become more pronounced as stage increases. Particularly once the level exceeds that of the bridge springers (approximately 1.9m above local datum). As headloss increases through the bridge the increased water levels upstream may also exacerbate bypassing, particularly on the left bank.</p> |
| Bed slope | <p>The bed slope at the gauge location has been estimated from 1:50,000 mapping as being approximately 0.0019m/m</p> |
| Roughness | <p>The in-channel roughness at the gauge location is relatively smooth; however, the floodplain roughness is much higher.</p> |

B.1.1.6 Bypass routes

During low to moderate flows bypassing of the gauge location will not be possible (as flow must pass under the bridge). However, as stage increases further and there is significant out of bank flow then left bank bypassing of the structures is considered possible. The road levels drop rapidly to floodplain level on the left bank. There are also gateways in the walls that will result in little resistance to floodplain flows. A cursory field estimation is that bypassing of the structure may begin to occur at a stage of between 2 and 2.5m above local datum.

The road level also drops on the right bank floodplain and although bypassing of the structure may be possible on this bank it is considered much more unlikely.

| | |
|---|--|
| <p>Looking towards Billa Bridge from the possible bypass route (left bank floodplain downstream of the bridge is visible on the left)</p> | <p>Looking towards Billa Bridge from the possible bypass route (left bank floodplain upstream of the bridge is visible on the right)</p> |
|  |  |
| <p>Right bank floodplain viewed from the bridge crest.</p> | <p>Looking north from the bridge crest (towards the left bank floodplain)</p> |
|  |  |

B.1.1.7 Additional photographs

| | |
|---|--|
| The Billa Bridge gauge hut | The Billa Bridge gauge hut |
|  |  |
| Looking downstream from Billa Bridge | Looking upstream from Billa Bridge |
|  |  |
| Gauge staff | Channel at Billa Bridge gauge |
|  |  |

B.1.2 Rating details

B.1.2.1 Check gaugings summary

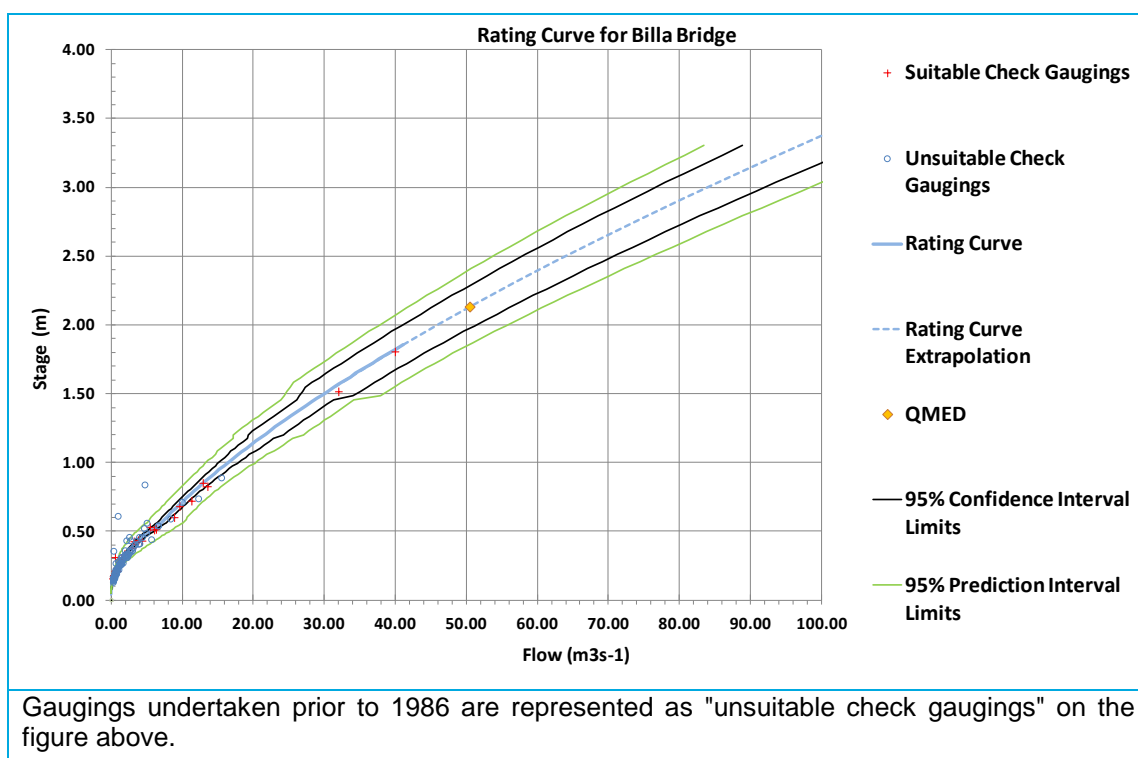
| | | | |
|--|--|--|-------------|
| No. of gaugings | 150 (45 since 01/11/1986) | Date range | 1955 - 2011 |
| Maximum gauged stage (m) | 1.80 | | |
| Approximate stage corresponding to QMED (m) | 2.13 | Extrapolation of rating to QMED (m) | 0.33 |
| Maximum observed stage (m) | 2.64 | Extrapolation to highest flow (m) | 0.84 |
| Other comments | The two earliest gaugings have been removed from the record as they appear to be clear outliers. | | |

B.1.2.2 Details of existing ratings

The existing rating is the 5th developed for the gauge and is considered applicable from 01/11/1986. Only check gaugings undertaken in this period have been used to assess the rating. The rating is currently comprises two limbs (although it was supplied as four limbs with two pair of identical equations).

The parameters for the existing rating where $Q = C (h - a)^b$ are given below:

| Limb No. | C | A | b | Min stage (m) | Max stage (m) |
|----------|--------|-------|-------|---------------|---------------|
| 1 | 16.500 | 0.005 | 2.500 | n/a | 0.490 |
| 2 | 17.000 | 0.005 | 1.910 | 0.490 | 2.095 |



B.1.2.3 Evaluation of existing rating

| | |
|--|--|
| Overall agreement with check gaugings | There is a good agreement with all check gaugings undertaken since 01/11/1986. |
| Range of applicability | The existing rating has been well checked at lower flows but there is a lack of check gaugings during periods of high flow. It is likely that the rating is fairly reliable up to approximately 1.8m. Above this level there are no further check gaugings and the springers on bridge will have a more pronounced impact on the water levels possibly contributing to bypassing. For these reasons the existing rating is not considered reliable above 1.8m. |
| Stability of rating | The gauge site appears relatively stable with no evidence of significant erosion or deposition. It is therefore considered unlikely that there will be significant alterations to the rating over time. This is particularly true of the hydraulic controls (bridge and road levels) affecting the high flows portion of the rating. It is more probable that the natural channel controls (which will have a greater impact on the stage discharge relationship at lower flows) may alter a small amount over time. |
| Uncertainty | Statistical analysis of the data shows 95% confidence interval at QMED is approximately 5.47m ³ /s; this represents 21.68% of QMED. However, the impact of the bridge (particularly the springers) is likely to become more pronounced at this stage and this will not be represented by the existing rating as it is well above the highest check gauging. Thus it is likely that there is a greater degree of uncertainty associated with QMED. |

B.1.2.4 Recommendations for rating improvement

As discussed in section B.1.1.5 the controls on the stage discharge relationship during high flows are complex and entirely different from the hydraulic controls at lower (in-bank) flows. Only two check gaugings have been undertaken at this site during periods of high flow. It is therefore recommended that attempts are made to undertake high flow gaugings when possible.

It is appreciated that whilst undertaking high flow gaugings at the site is a good aspiration it does not provide an immediate solution for improving the reliability of the high flow rating. For this purpose we recommend undertaking hydraulic modelling. The nature of the watercourse and hydraulic controls at this site mean that a 1d model should provide a useful tool for extending the existing rating. This model should include the major hydraulic controls (the bridge and downstream channel). A total of seven cross sections have been specified in order to develop this hydraulic model. The first two of these are upstream of the gauge location. It may also be beneficial if the surveyors are able to survey the bank heights along this section of the channel. One further cross section is located at the upstream face of the bridge (gauge location). The remaining four cross sections are located downstream of the bridge and extend for approximately 700m (this reach will probably form the main hydraulic control during low to moderate flows).

B.2 Rating review - Ballygrania

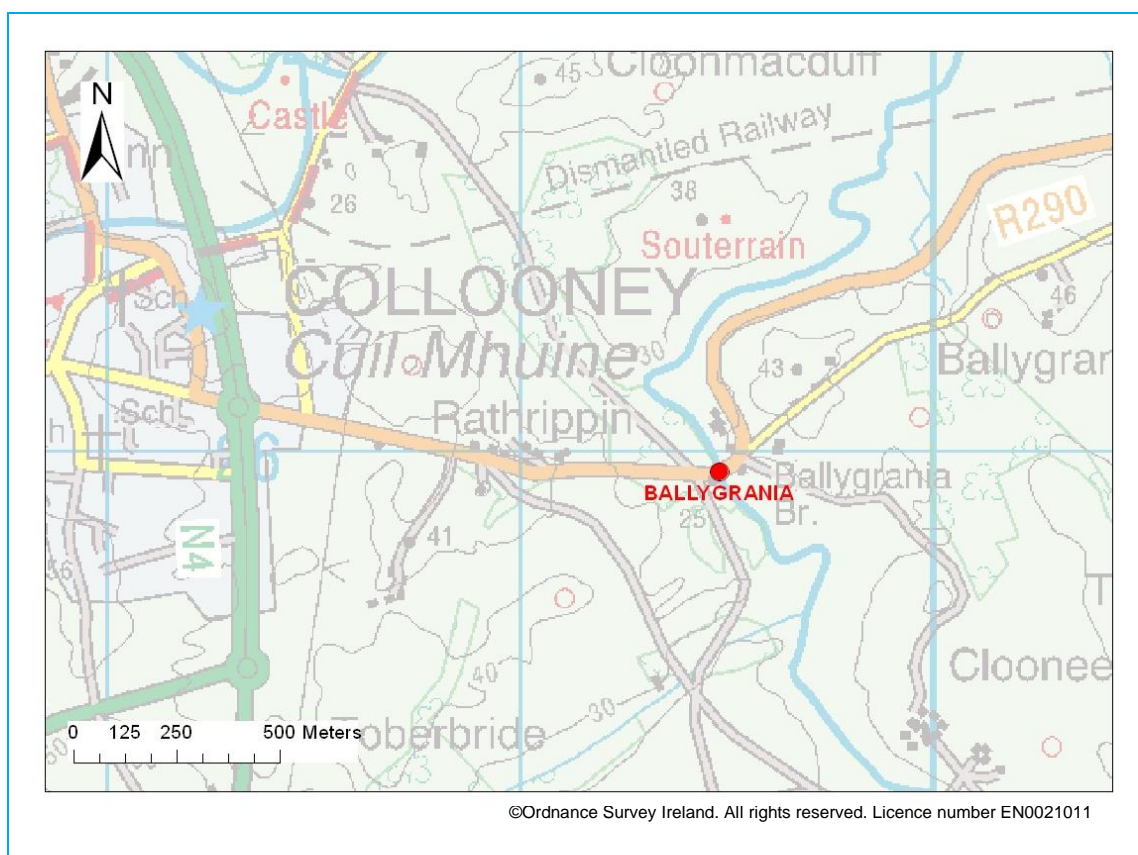
B.2.1 Station description

B.2.1.1 Gauge summary

| | | | |
|-----------------------|---------------|--------------------|---------------|
| Station name | Ballygrania | Site type | Velocity-area |
| Station number | 35003 | Watercourse | Unshin River |
| Grid reference | 169480 325952 | Operator | OPW |

B.2.1.2 Location


The gauge is located on the left bank of the river immediately downstream of the road bridge.




B.2.1.3 Gauge Datum

| | |
|--|---|
| Gauge datum (mAOD) | 27.665 |
| Means of confirmation (e.g. survey) | Supplied by OPW |
| Other comments (e.g. gauge boards) | Gauge board located on the downstream face of the bridge pier (visible from gauge hut). Gauge board only extends to 2m. |

B.2.1.4 Control on stage discharge relationship

| Type of section | Open channel (downstream of bridge) |
|----------------------|--|
| Low flow control(s) | <p>There is no formal hydraulic control structure at this gauge.</p> <p>At low flows the dominant hydraulic control will be the channel geometry both at and downstream of the gauge location. There is significant weed growth on the right bank of the watercourse; it is possible that this might result in seasonal alterations to the stage discharge relationship.</p> |
| |  |
| High flow control(s) | <p>At higher flows the controls on water level at the site will become more complex. The channel geometry at the site will still have a strong influence and there is still the potential for backwater influences from downstream. However, the influence of the bridge upstream will also become more pronounced, particularly if this results in bypassing of the gauge or the formation of critical flow in the region of the gauge.</p> |

| | |
|------------------|--|
| |  |
| Bed slope | The bed slope at the gauge has been estimated from 50k mapping to be approximately 0.001. |
| Roughness | The hydraulic roughness at the gauge location is relatively low; however, there is a possibility that might be affected by seasonal vegetation growth. |

B.2.1.5 Bypass routes

Out of bank flow will occur at moderate flows but the bridge upstream is unlikely to be bypassed. For this reason high flow gaugings may best be taken directly from the bridge. If bypassing of the gauge were to occur then the most likely route is over the road on the left bank; hydraulic modelling will be required in order to assess whether this is possible during extreme flows.

| From the bridge, looking west towards the left bank floodplain. | From the bridge looking east towards the right bank floodplain |
|---|--|
|  |  |

B.2.1.6 Additional photographs

| | |
|---|--|
| Ballygrania gauge | Ballygrania gauge |
|  |  |
| Gauge staff | Looking upstream from road bridge |
|  |  |
| Looking east from road bridge (towards right hand floodplain) | Looking west from road bridge (towards left bank floodplain) |
|  |  |

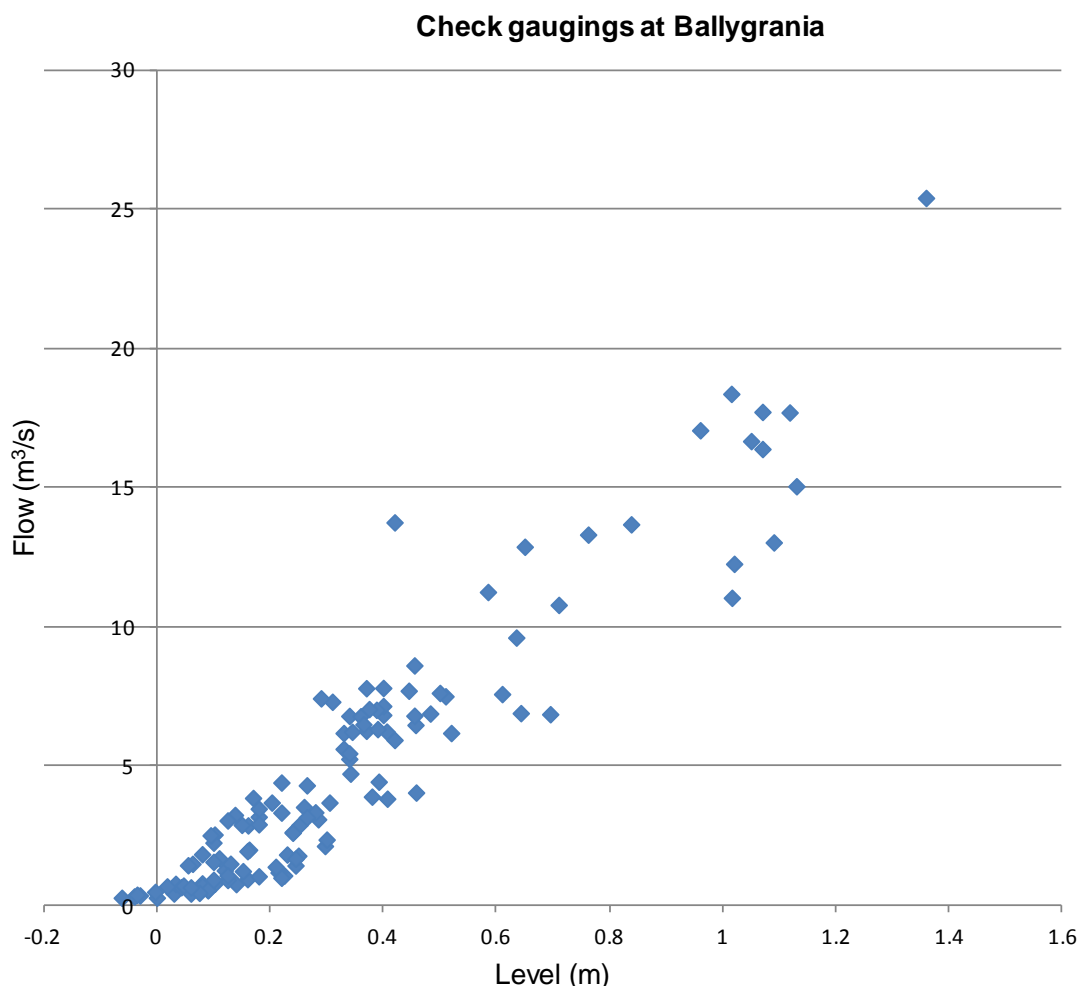
B.2.2 Rating details

B.2.2.1 Check gaugings summary

| | | | |
|--|------|--|-------------|
| No. of gaugings | 122 | Date range | 1940 - 2011 |
| Maximum gauged stage (m) | 1.36 | | |
| Approximate stage corresponding to QMED (m) | 1.45 | Extrapolation of rating to QMED (m) | n/a |
| Maximum observed stage (m) | 1.52 | Extrapolation to highest flow (m) | n/a |
| Other comments | None | | |

B.2.2.2 Details of existing rating

At present there is no existing rating at this site. The plot below shows all the check gaugings we have been supplied. It is clear from this plot that whilst there are a lot of gaugings there is also a significant amount of scatter. Given the presence of vegetation growth in the channel it is recommended that at subsequent rating development should be checked for seasonal influences.



B.2.2.3 Recommendations for rating development

In order for a rating to be developed at this site we recommend developing a hydraulic model. The outputs of this hydraulic model can then be used in combination with the existing check gaugings to develop a rating curve applicable to the full range of predicted flows occurring at this site. Given the fact that significant bypassing is unlikely and if it were to occur the spill over the road would be the control we consider a 1D hydraulic model most suitable for this location.

Given the absence of a formal hydraulic control at this site it will be necessary to extend the model for at least one backwaters length downstream of the gauge location. This has been estimated to be approximately 1.4km. It is therefore recommended the river channel downstream of the gauge location is surveyed as far where it passes through the old railway embankment. The hydraulic model will need to extend much less distance upstream of the gauge location and it is anticipated that a single section upstream of the road bridge will suffice. It is important that the hydraulic model includes a surveyed cross section at the gauge location and accurately represents the bridge upstream. It is anticipated that a total of seven cross sections will be required to develop this hydraulic model.

B.3 Rating review - Big Bridge

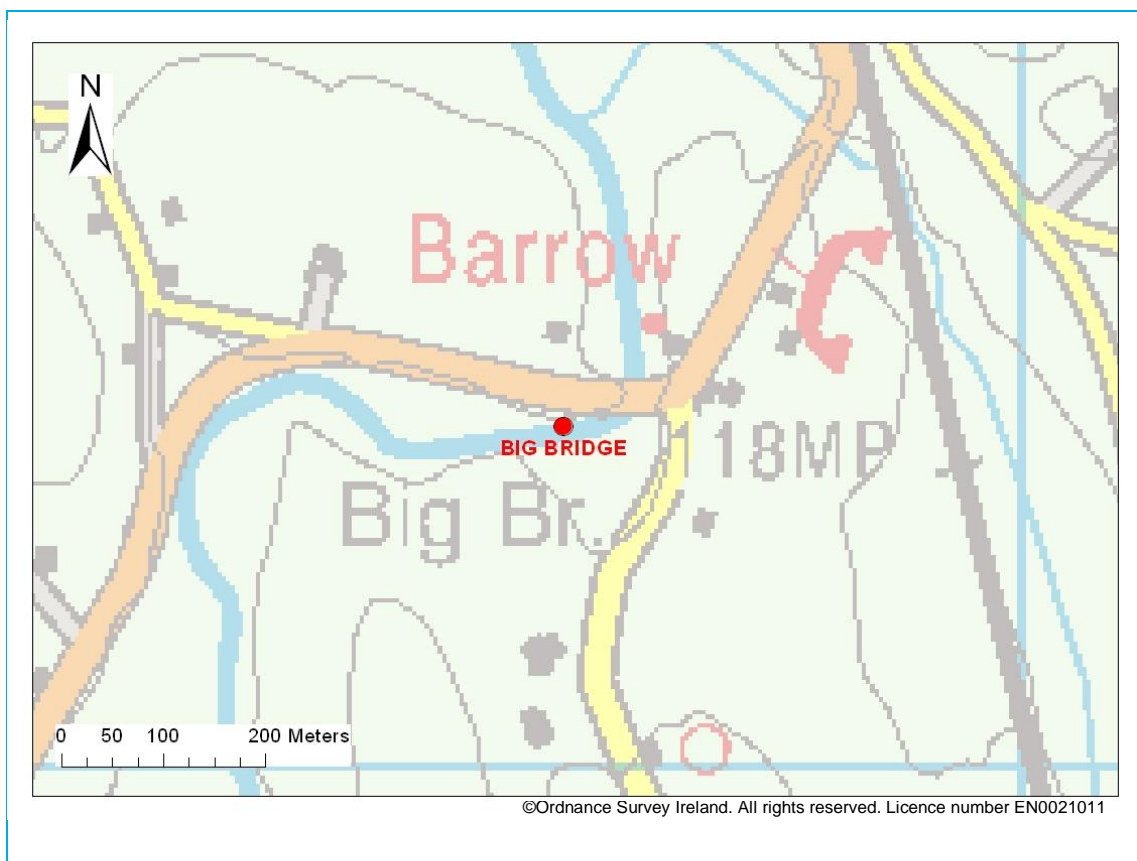
B.3.1 Station description

B.3.1.1 Gauge summary

| | | | |
|-----------------------|---------------|--------------------|----------------|
| Station name | Big Bridge | Site type | Velocity-area |
| Station number | 35004 | Watercourse | Owenmore River |
| Grid reference | 166588 312335 | Operator | OPW |

B.3.1.2 Location

The gauging station is located approximately 50m upstream of the road bridge on the left bank of the watercourse. However, the gauge boards are attached to the upstream face of the bridge pillars.



B.3.1.3 Gauge Datum


| | |
|--|---|
| Gauge datum (mAOD) | Gauge datum level is not known. |
| Means of confirmation (e.g. survey) | n/a |
| Other comments (e.g. gauge boards) | There are currently two gauge boards mounted on the bridge pillars. However, these gauge boards are not mounted at the same height. It seems likely that the newer looking board facing the left bank is the correct one; this should be clarified. |

B.3.1.4 Description / other comments

The gauge is located approximately 50m upstream of the road bridge on the left bank of the watercourse. Between the gauge location and the bridge the river meanders sharply leftwards. At the gauge location the left bank rises relatively steeply towards the roadway. Conversely the right bank includes a relatively broad floodplain however this rapidly narrows downstream of the gauge towards the bridge.

It is understood that the gauge was relocated in 1998 from the downstream face of the bridge.


B.3.1.5 Control on stage discharge relationship

| Type of section | Open channel |
|----------------------|---|
| Low flow control(s) | <p>There is no formal hydraulic control for low flows. Instead the stage discharge relationship will be affected by a combination of the natural channel geometry and possibly downstream hydraulic influences. The bridge is the most obvious structure which may affect the stage discharge relationship at the gauge but this influence is likely to be most pronounced during higher flows.</p>  |
| High flow control(s) | <p>At higher flows the impact of the road bridge downstream will probably become the dominant influence on the stage discharge relationship at the gauge location. The bridge comprises of 5 sprung arch openings; one of these is located on the left bank floodplain, two in the channel and the remaining two on the right bank floodplain. It is also anticipated that the stage discharge relationship will be affected significantly once the banks are overtopped.</p> |

| | |
|-------------------------|---|
| |  |
| <p>Bed slope</p> | <p>The bed slope at the gauge has been estimated from 1:50,000 mapping as being approximately 0.0043m/m</p> |

B.3.1.6 Bypass routes

At the gauge location it is probable that the channel will be bypassed by floodplain flow (primarily on the right bank) during periods of high flow. The flow at which this occurs may also be influenced by the backwater effect of the bridge. However, it is considered unlikely that the bridge will be bypassed. For this reason, it may be preferable to gauge high flows at the bridge rather than exactly at the gauge location.

| Far right bank floodplain | Right bank floodplain |
|---|--|
|  |  |

B.3.1.7

B.3.1.8

B.3.1.9

B.3.1.10 Additional photographs

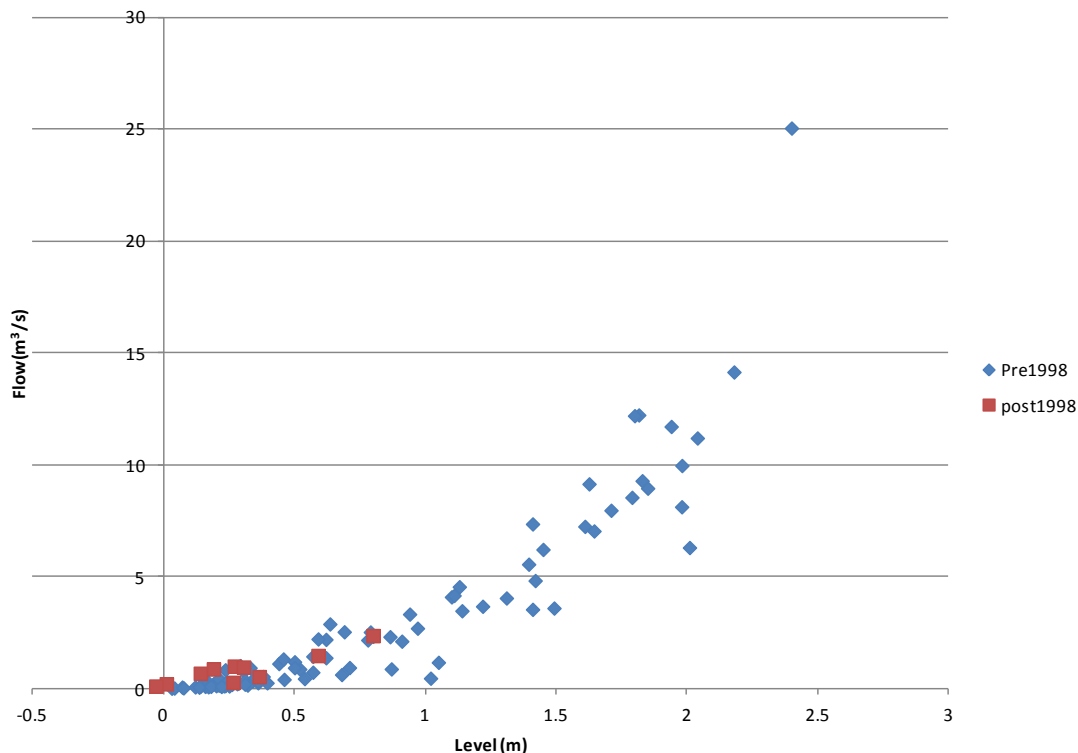


B.3.2 Rating details

B.3.2.1 Check gaugings summary

| | | | |
|--|---|--|----------------------------|
| No. of gaugings | 122 | Date range | 1942 - 2011 |
| Maximum gauged stage (m) | 2.40 (0.80 since 1998) | | |
| Approximate stage corresponding to QMED (m) | n/a | Extrapolation of rating to QMED (m) | n/a |
| Maximum observed stage (m) | 2.97 (within supplied digital data from 2007) | Extrapolation to highest flow (m) | 2.17 (in data since 1998) |
| Other comments | None | | |

Flow gaugings at Big Bridge



B.3.2.2 Details of existing rating

There is no existing rating for this gauge.

B.3.2.3 Recommendations for rating improvement

Prediction of the high flow rating at this location is complex due to the combined effects of the downstream bridge and overbank flow. In order to predict this we will build a hydraulic model of the river along this reach. Given that the dominant control on the high flow rating is likely to be the downstream bridge it is probable that a 1D model of the channel and floodplain will provide the best approach for predicting the stage discharge relationship at extreme flows. The lack of defined hydraulic control at low flows means that the hydraulic model should be extended downstream for at least one back water length, this has been estimated to be approximately 400m along this reach. A total of six cross sections have been proposed in order to develop a hydraulic model of this gauge. One of these should be located at the gauge location and one at the road bridge. Of the remaining section, one should be located upstream of the gauge and the remaining three downstream of the bridge.

It is also recommended that additional check gaugings should be undertaken using levels recorded at the new gauge location. There are currently no high flow gaugings since the station was relocated to the upstream side of the bridge.

B.4 Rating review - Ballysadare

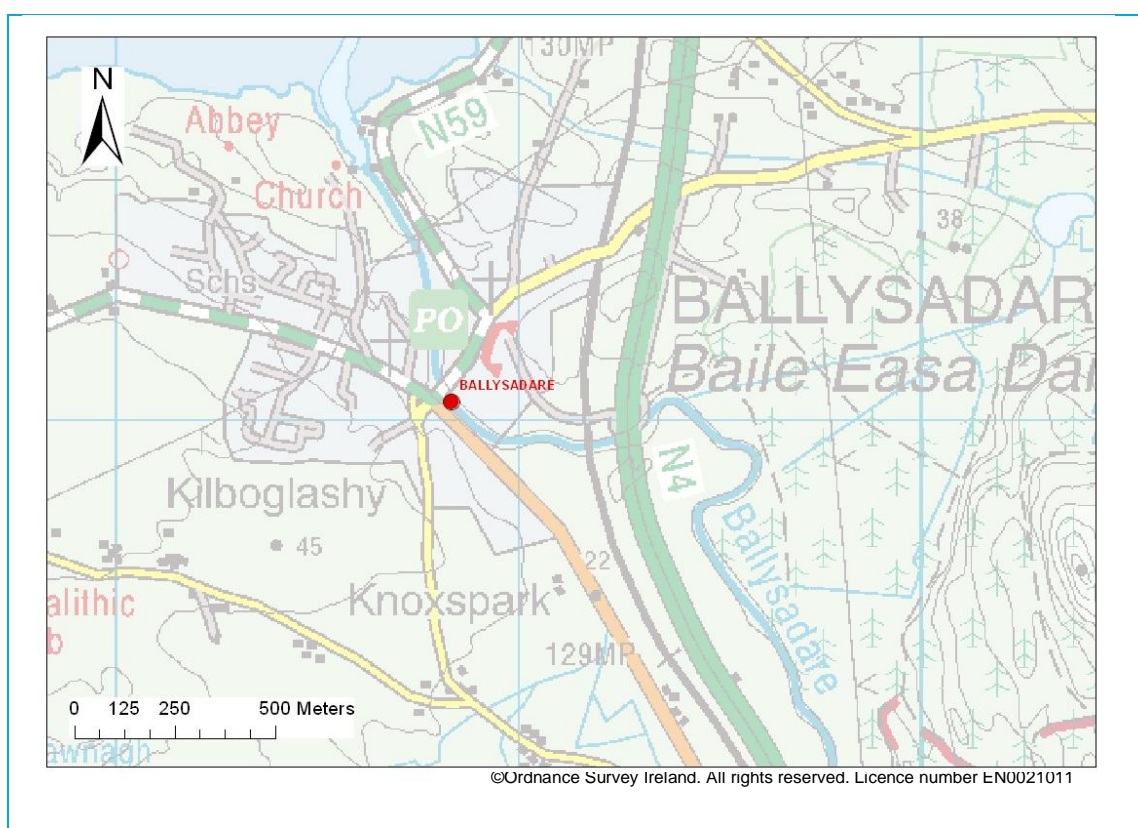
B.4.1 Station description

B.4.1.1 Gauge summary


| | | | |
|-----------------------|---------------|--------------------|-------------------|
| Station name | Ballysadare | Site type | Velocity-area |
| Station number | 35005 | Watercourse | Ballysadare River |
| Grid reference | 166807 329027 | Operator | OPW |

B.4.1.2 Location

The gauge is located on the left bank of the river immediately upstream of the Main Street bridge.






B.4.1.3 Gauge Datum

| | |
|--|---|
| Gauge datum (mAOD) | 22.68 |
| Means of confirmation (e.g. survey) | Supplied by OPW |
| Other comments (e.g. gauge boards) | <p>Gauge board located on the left bank, easily visible from the bank. Gauge board only extends to 2m.</p>  |

B.4.1.4 Description/ other comments

B.4.1.5 Control on stage discharge relationship

| Type of section | Natural open channel. |
|---------------------|--|
| Low flow control(s) | <p>There is no formal hydraulic control structure at this gauge.</p> <p>At low flows the dominant hydraulic control will be the weir located approximately 100 m downstream of the Main Street Bridge. A significant hydropower plant is located on the left bank of this weir and a large proportion of flows could be expected to bypass the weir via this route.</p> <p>The channel downstream of the gauge to the bridge has vegetated banks on both banks with some overhanging trees on the right bank. A raised wall runs along the left bank and ties into the bridge.</p> <p>Downstream of the bridge the channel is again vegetated at low levels with retaining walls set back from the banks at higher levels.</p>  <p>Looking upstream from Main Street Bridge</p> |

| | |
|----------------------|---|
| |  <p>Looking downstream from Main Street Bridge</p> |
| High flow control(s) | <p>At higher flows it is still expected that flood waters will remain in bank with no bypassing reported. There is potential for the Main Street Bridge to have an increasing influence on the stage discharge relationship at higher flows.</p>  <p>Looking downstream to Main Street Bridge</p> |
| Bed slope | <p>Given the proximity of the gauge to a large weir it has not been possible to provide a reliable estimate of bed slope purely from OS mapping. This will be provided once survey of the gauged reach is completed.</p> |
| Roughness | <p>The in-channel roughness is relatively low at the gauge location; however this will increase slightly as the floodplains become inundated.</p> |

B.4.1.6 Bypass routes

The lowest potential bypass route is located on the right bank where out of bank flows would flood the properties on Main Street. There is no indication that this has ever occurred. It is also noted that the access point to the gauge site provides a low point in the wall on the left bank.

| From the bridge, looking towards the left bank. | From the bridge, looking towards the right bank. |
|--|--|
|  |  |
| Opening to gauge station in wall on left bank | |
|  | |

B.4.1.7 Additional photographs

| | |
|---|---|
| Downstream weir from left bank looking across stream | Downstream weir from left bank looking downstream |
|  |  |
| Hydropower sluice gates on left bank at weir | Temporary cabins on right bank opposite gauge |
|  |  |
| Looking upstream to weir | |
|  | |

B.4.2 Rating details

B.4.2.1 Check gaugings summary

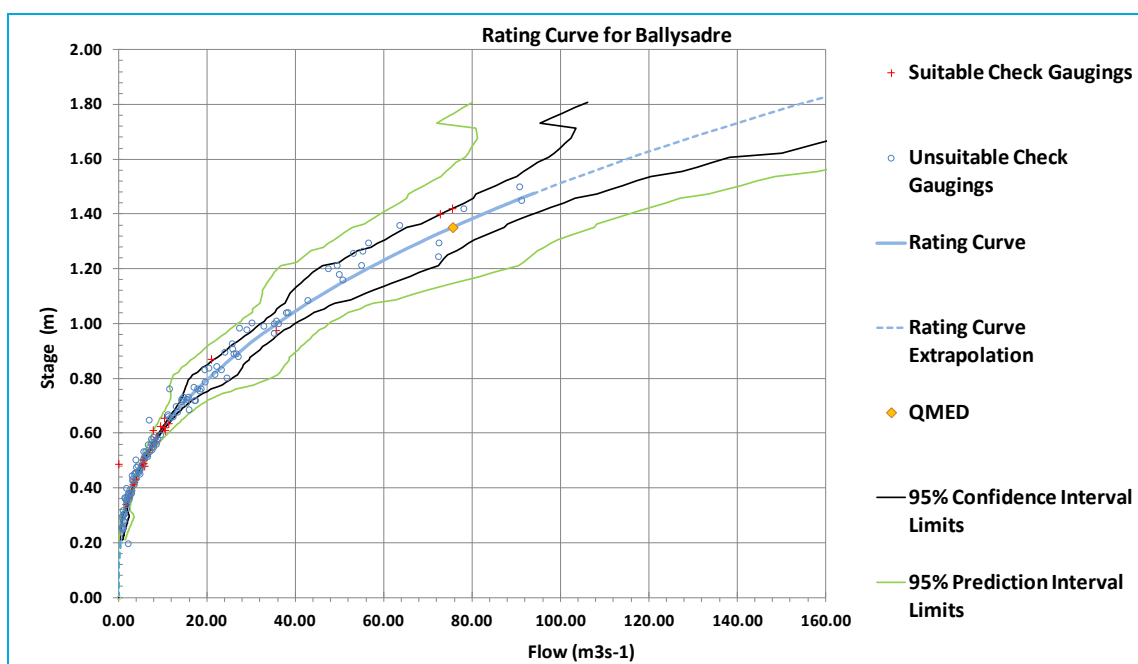
| | | | |
|--|--|--|-------------|
| No. of gaugings | 158 (33 since 1996) | Date range | 1945 - 2011 |
| Maximum gauged stage (m) | 1.42 | | |
| Approximate stage corresponding to QMED (m) | 1.38 | Extrapolation of rating to QMED (m) | n/a |
| Maximum observed stage (m) | 1.743 | Extrapolation to highest flow (m) | 0.323 |
| Other comments | Our statistical analysis of the current rating has been undertaken using only the check gaugings taken during the period the rating is considered applicable (1996 onwards). | | |

B.4.2.2 Details of existing rating

The current rating is the sixth to have been developed for this gauge and is considered to be valid from the beginning of 1996. It is a compound rating comprising of two limbs.

The parameters for the existing rating where $Q = C(h - a)b$ are given below:

| Limb No. | C | A | b | Min stage (m) | Max stage (m) |
|----------|--------|---|-------|---------------|---------------|
| 1 | 37.286 | 0 | 2.705 | 0.000 | 0.843 |
| 2 | 35.874 | 0 | 2.479 | 0.843 | 1.475 |



B.4.2.3 Evaluation of existing rating

| | |
|--|--|
| Overall agreement with check gaugings | <p>As described above, only the check gaugings undertaken during the period the current rating is considered valid (1996 onwards) were used in the statistical analysis. However, all check gaugings are plotted in the figure above with those undertaken prior to 1996 being displayed as unsuitable. It is clear from this figure that there is no significant change in the data recorded prior to and after 1996. It would therefore be useful to gain a better understanding why the current rating is not thought to be applicable to this data. If these additional check gaugings can be included then they would improve our confidence in the high flows rating at the site.</p> <p>Whilst there is generally a good agreement between the check gaugings and the existing rating there is also considerable scatter and a lack of (recent) high flow gaugings.</p> <p>It is possible that the operation of the downstream hydropower station may impact the rating at the gauge location. Whilst it will take more work to confirm this it is a possible reason for the scatter in the rating.</p> |
| Range of applicability | The rating is currently considered suitable for levels below 1.475m that were recorded after 1996. |
| Stability of rating | Whilst there is no indication of sediment accumulation or deposition at the site, as previously discussed it is possible that the operation of the downstream hydropower station may impact the reliability of the rating. |
| Uncertainty | Using only the check gaugings undertaken since 1996, the 95% confidence interval at QMED is estimated to be $11\text{m}^3/\text{s}$; this represents 29% of QMED. |

B.4.2.4 Recommendations for rating improvement

An improved understanding of why the current rating is not considered suitable for data recorded prior to 1996 would help when deciding whether earlier check gaugings should be included in further analysis.

An improved knowledge of how the downstream hydropower station operates and its effect on water levels is essential to understanding the reliability of the rating at the gauge location.

The development of a hydraulic model will help in the development of a more reliable high flow rating at this gauge. The gauged section of watercourse has been identified as an HPW and will therefore be part of a larger hydraulic model. It is anticipated that this model will already represent the gauged reach in sufficient detail that the model can be used for improving the high flows rating. It is important though that the dominant hydraulic controls (road bridge, weir, and hydropower controls) are adequately represented in the model as well as ensuring that a cross section is included at the gauge location. For the purposes of the rating reviews the hydraulic model will need to extend to just downstream of the weir and upstream far enough to ensure that possible bypassing on the right bank can be represented (approximately 250m upstream of the gauge). It is likely that a 1D hydraulic model will be sufficient and able to represent the main hydraulic controls at this location; however, if bypassing is found to be significant during the highest flows then a local 2D domain can be added to the model in this location.

B.5 Rating review - New Bridge, Sligo

B.5.1 Station description

B.5.1.1 Gauge summary


| | | | |
|-----------------------|---------------|--------------------|----------------------|
| Station name | New Bridge | Site type | Velocity-area |
| Station number | 35012 | Watercourse | Garvoge River |
| Grid reference | 169396 335963 | Operator | Sligo County Council |

B.5.1.2 Location

The gauge is located on the left bank of the river a short distance upstream of the Bridge Street bridge, (New Bridge).




B.5.1.3 Gauge Datum

| Gauge datum (mAOD) | |
|---|--|
| Means of confirmation (e.g. survey) | |
| <p>Other comments (e.g. gauge boards)</p> | <p>Gauge board located on the downstream face of local outcropping from left bank, easily visible from the bank. Gauge board only extends to 2m.</p>  |


B.5.1.4 Description/ other comments

B.5.1.5 Control on stage discharge relationship

| Type of section | Modified open channel with retaining walls on both banks immediately downstream of site, more natural channel on right bank in vicinity of gauge. |
|---------------------|--|
| Low flow control(s) | <p>There is no formal hydraulic control structure at this gauge.</p> <p>At low flows the dominant hydraulic control will be the weir located approximately 300 m downstream of the gauge immediately upstream of the Lower Knox Street bridge (Hyde Bridge).</p> <p>The channel geometry downstream of this point is reasonably consistent with retaining walls to bank top on both banks extending to the downstream weir.</p> <p>Upstream of this point there are a number of overhanging trees but these are not expected to impact of the rating at lower flows. The flow depth is relatively shallow despite the wide channel. Flows have a reasonable velocity even at low levels suggesting a reasonable gradient and the bed material as a result is predominantly gravels with limited weed growth.</p> <p>It should also be noted that a significant weir (John Fallon Weir) is located approximately 300 m upstream of the gauge.</p>  <p>Looking upstream from New Bridge</p> |




Weir upstream of Hyde Bridge

| | |
|------------------------------------|---|
| <p>High flow control(s)</p> | <p>At higher flows it is still expected that flood waters will remain in bank until extreme events. It has however been indicated by Sligo County Council that as flows increase the importance of New Bridge as the hydraulic control increases with this structure providing the main influence on water levels in extreme events.</p> <p>The bridge itself has six arches and a three high flow culverts were observed on the left bank which are assumed to drain to a seventh arch in this location, see below.</p>  <p>Looking downstream from gauge to New Bridge</p> |
| <p>Bed slope</p> | <p>Given the proximity of this gauge to a large weir and the sea it is not possible to provide a reliable estimate of channel gradient of the available mapping. This will be best done once this reach has been surveyed.</p> |
| <p>Roughness</p> | <p>The in-channel hydraulic roughness is very low along the gauged reach.</p> |






B.5.1.6 Bypass routes

It is not expected that flows will exceed bank top at New Bridge; there are a number of high flow culverts on the left bank to provide additional capacity past this structure.

| From the bridge, looking towards the left bank. | From the bridge, looking towards the right bank. |
|---|--|
|  |  |

| Looking towards the left bank upstream face of New Bridge. | Looking towards the left bank downstream face of New Bridge. |
|---|--|
|  <p>A photograph showing the upstream face of New Bridge. The bridge is a stone structure with two large arches. A car is visible on the road above the bridge. The water is flowing through the arches.</p> |  <p>A photograph showing the downstream face of New Bridge. The bridge is a stone structure with two large arches. A blue railing is visible on the right side. The water is flowing through the arches.</p> |

B.5.1.7 Additional photographs

| | |
|---|---|
| Downstream Weir and Fish Pass | Hyde Bridge |
|  |  |
| John Fallon Weir looking to left bank | Channel downstream of John Fallon Weir |
|  |  |
| Looking upstream from right bank to Hyde Bridge | |
|  | |

B.5.2 Rating details

B.5.2.1 Check gaugings summary

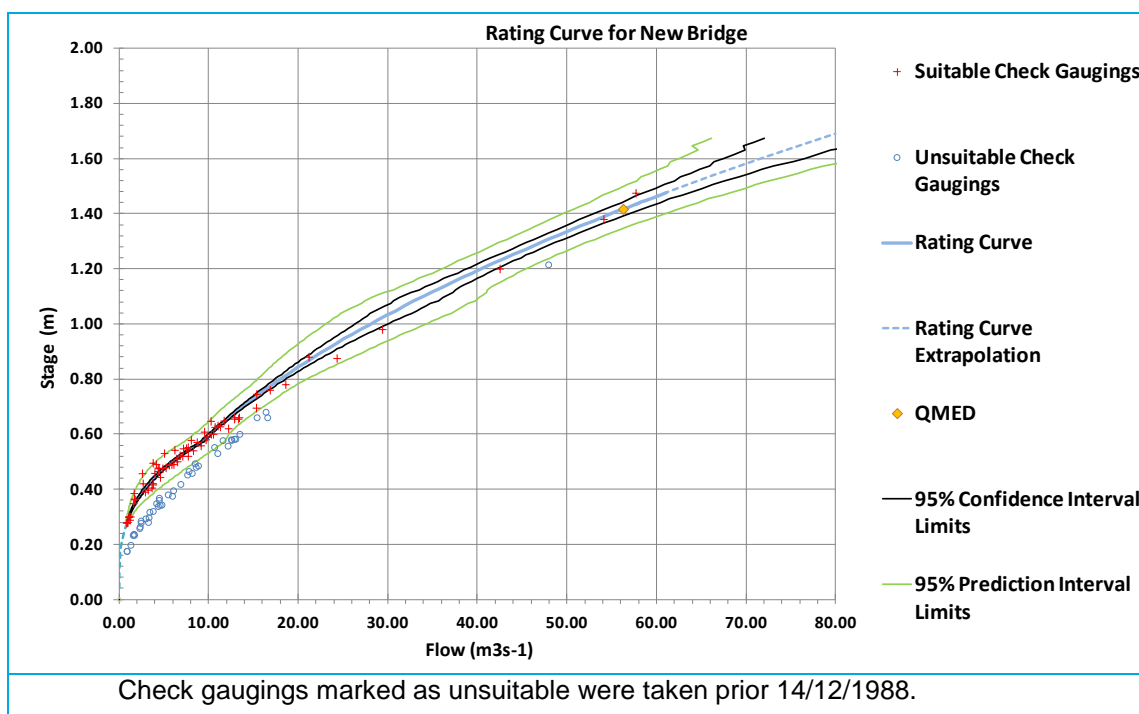
| | | | |
|--|---------------------|--|-------------|
| No. of gaugings | 115 (71 since 1988) | Date range | 1980 - 2011 |
| Maximum gauged stage (m) | 1.475 | | |
| Approximate stage corresponding to QMED (m) | 1.410 | Extrapolation of rating to QMED (m) | None |
| Maximum observed stage (m) | 1.556 | Extrapolation to highest flow (m) | 0.081 |
| Other comments | None | | |

B.5.2.2 Details of existing rating

As far as we are aware this is only rating that has been developed for this gauge; however, it is only considered valid for data recorded after 14/12/1988 (this is miss-typed as 1988 in the supplied data). We do not know why the existing rating is not applicable for data recorded prior to this but the supplied check gaugings do suggest that there was a change to either the recording datum or the hydraulic control.

The parameters for the existing rating where $Q = C (h - a)^b$ are given below:

| Limb No. | C | A | b | Min stage (m) | Max stage (m) |
|-----------------|----------|----------|----------|----------------------|----------------------|
| 1 | 59.0334 | 0 | 3.31107 | 0.277 | 0.570 |
| 2 | 28.1206 | 0 | 1.99329 | 0.570 | 1.475 |



B.5.2.3 Evaluation of existing rating

| | |
|--|--|
| Overall agreement with check gaugings | Generally there is a very good agreement between the existing check gaugings and the rating, even at flows up to QMED. |
| Range of applicability | The existing rating is considered applicable for stages between 0.277 and 1.475 (the gauged range). It is also only considered suitable for data recorded after 14/12/1988. The reason for this is unclear, if it does only to change in the recorded datum level then older data should be adjusted accordingly and also included in the rating development. |
| Stability of rating | The rating appears very stable with little scatter even at the largest gauged flows (around QMED). |
| Uncertainty | <p>The confidence intervals associated with the rating up to the gauged limit are narrow (the 95% confidence interval at QMED is $2.06\text{m}^3/\text{s}$, or approximately 7% of QMED), this is due to the relatively large number of gaugings that have been under taken and the small amount of scatter within the gaugings.</p> <p>The degree of uncertainty will increase rapidly above this point if the existing rating is extrapolated. This is due both to the lack of gauged data at higher flows and because of the increasing influence of New Bridge as an important hydraulic control.</p> |

B.5.2.4 Recommendations for rating improvement

The existing rating appears to fit the gauged data well at flows lower than QMED; whilst it may be possible to further improve confidence in this by including older gaugings the impact will probably be minor. The most important way that the existing rating can be improved is by enabling it to be extended with confidence to higher flows. One way this can be achieved is by prioritising high flow gaugings at this site when possible. However, a more immediate solution is to develop a hydraulic model of the gauged reach, including important hydraulic controls. This model can be calibrated using the existing gauged data and then be use to extend the rating to higher flows. In order to do this it will be necessary to develop a 1D hydraulic model that include the gauge site and downstream hydraulic controls.

B.6 Rating review - New Bridge (Manorhamilton)

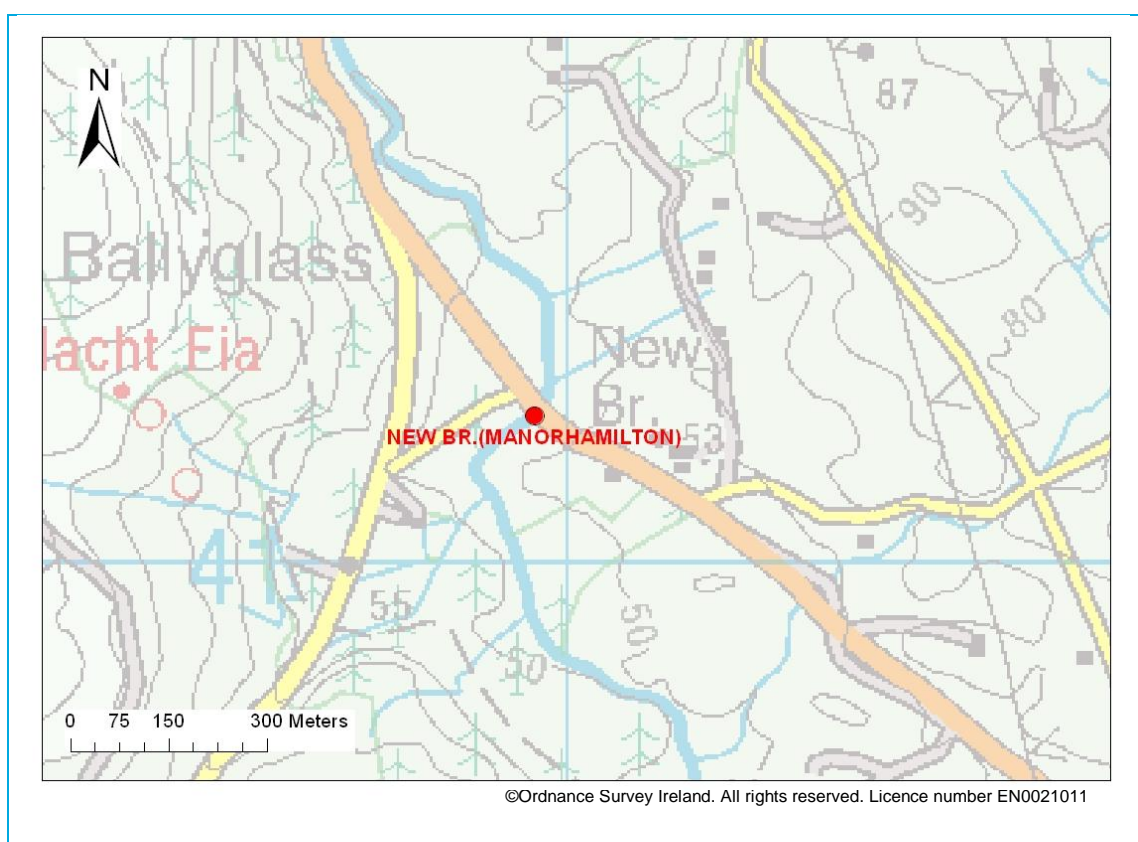
B.6.1 Station description

B.6.1.1 Gauge summary

| | | | |
|-----------------------|----------------------------|--------------------|---------------|
| Station name | New Bridge (Manorhamilton) | Site type | Velocity-area |
| Station number | 35028 | Watercourse | Bonet River |
| Grid reference | 186949 341225 | Operator | OPW |

B.6.1.2 Location

The gauge is located immediately downstream of the road bridge on the right bank.



B.6.1.3 Gauge Datum



| | |
|--|---|
| Gauge datum (mAOD) | 50.58mAOD |
| Means of confirmation (e.g. survey) | Supplied by OPW |
| Other comments (e.g. gauge boards) | There are two gauge boards at this station. The first is located on the bridge pier, the second on the wall by the stilling well. Both appear to read the same level. |

B.6.1.4 Description/ other comments

The gauge is located immediately downstream of the bridge on the right bank. There is what appears to be a depositional bar forming near the base of the stilling well which may have implications for stability of the rating over time.

Upstream of the bridge the river meanders around a playing field on the right bank.

B.6.1.5 Control on stage discharge relationship

| Type of section | Bridge |
|----------------------|---|
| Low flow control(s) | <p>The dominant low flow control is likely to be the natural channel at the gauge location and downstream. It is also possible that slight changes in the structure of the depositional bar at the bridge will impact the results from the gauge.</p>  |
| High flow control(s) | <p>At higher flows the impact of the upstream bridge may become pronounced particularly if it either causes bypassing of the structure or if it results in supercritical flow. The later of these will be particularly hard to model accurately. Level data recorded at this gauge during the October 2008 event shows a slightly fluctuating water level at the peak, this may indicate changing hydraulic controls resulting from the migration of a hydraulic jump.</p>  |

| | |
|------------------|---|
| Bed slope | The channel gradient at the gauge location has been estimated from 1:50,000 mapping to be approximately 0.0045m/m |
| Roughness | In-channel roughness is moderate. |

B.6.1.6 Bypass routes

There is potential for extensive bypassing on the right bank of the structure.

Once the right bank upstream of the bridge becomes overtopped a flow route is possible over the playing fields, across the road and onto the floodplain downstream of the bridge. There is potential for this route to convey a significant flow during very extreme events. Hydraulic modelling would be required in order to assess the flow at which this bypassing occurs.

| | |
|--|--|
| From the bridge looking upstream towards the playing field on the right bank. | Looking north west from the bridge along the road over which bypassing may occur. |
|  |  |
| Looking upstream from the road on the right bank. | Looking downstream from the road on the right bank. |
|  |  |

B.6.1.7 Additional photographs

| | |
|--|---|
| New Bridge gauge | Looking downstream from New Bridge |
|  |  |
| New Bridge gauge | Gauge board on bridge pier |
|  |  |
| Gauge board and stilling well | Looking upstream from New Bridge |



B.6.2 Rating details

B.6.2.1 Check gaugings summary

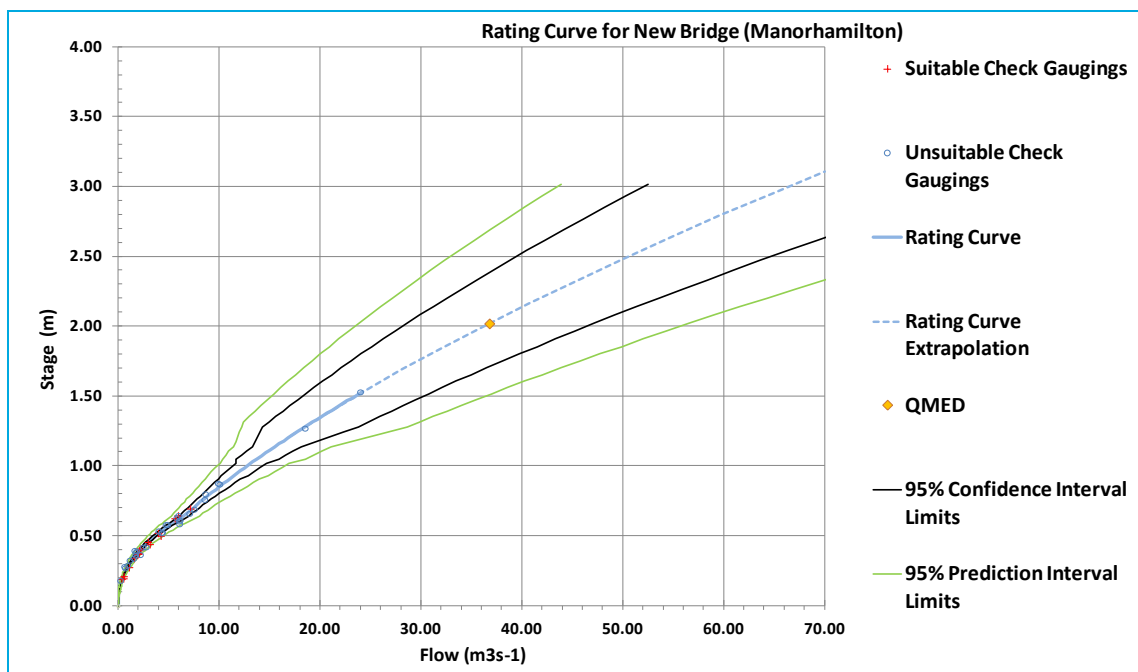
| | | | |
|--|---|--|-------------|
| No. of gaugings | 48 (17 post 1995) | Date range | 1991 - 2008 |
| Maximum gauged stage (m) | 1.53 | | |
| Approximate stage corresponding to QMED (m) | 2.02 | Extrapolation of rating to QMED (m) | 0.49 |
| Maximum observed stage (m) | 2.35 | Extrapolation to highest flow (m) | 0.82 |
| Other comments | For the analysis below only check gaugings undertaken during the period for which the rating is considered applicable (1995 onwards) were used. | | |

B.6.2.2 Details of existing rating

The supplied rating is third rating developed for this gauge but the only one that has been supplied. It is a compound rating comprising three limbs and is considered valid for data recorded after the beginning of 1995.

The parameters for the existing rating where $Q = C (h - a)^b$ are given below:

| Limb No. | C | A | b | Min stage (m) | Max stage (m) |
|-----------------|----------|----------|----------|----------------------|----------------------|
| 1 | 30 | -0.03 | 2.880 | 0.00 | 0.260 |
| 2 | 17 | -0.02 | 2.406 | 0.26 | 0.640 |
| 3 | 13 | 0.010 | 1.490 | 0.64 | 1.529 |



B.6.2.3 Evaluation of existing rating

| | |
|--|--|
| Overall agreement with check gaugings | <p>Generally the check gaugings show little scatter and have good agreement with the existing rating. It is noted though that there are no check gaugings undertaken more recently than 2008; this may be a concern given the apparent deposition which appears to be occurring adjacent to the stilling well.</p> <p>As noted above, we have based our assessment only on check gaugings undertaken during the period for which the rating is considered applicable. However, appears that there is no significant change in the data recorded prior to 1995, in fact inclusion of this data results in increased confidence in the rating at QMED. It would therefore be useful to understand why the rating is not considered applicable for data recorded prior to 1995.</p> |
| Range of applicability | <p>The existing rating is considered suitable for data recorded after 1995. It is also only currently recommended for levels up to 1.529m. Extrapolation may be quite uncertain as the effects of the upstream bridge might become significant. The data recorded at the site shows signs of a fluctuating water level during the largest peak on record possibly as a result of a hydraulic jump.</p> |
| Stability of rating | <p>There is some concern about the stability of the rating at this gauge given the apparent deposition around the stilling well. However, there are no clear long term trends in the check gauging data (although the most recent gauging was undertaken in 2008).</p> |
| Uncertainty | <p>Statistical analysis of the supplied data shows 95% confidence interval at QMED to be approximately 9.26m³/s; this represents 50% of QMED.</p> |

B.6.2.4 Recommendations for rating improvement

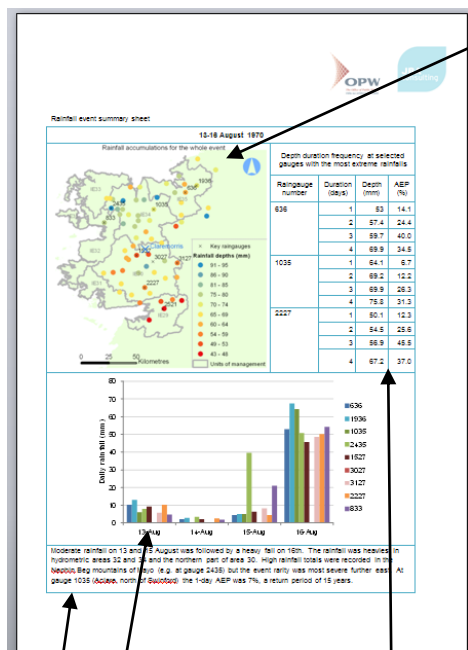
Firstly, it would be beneficial to know why the rating is not considered suitable for data recorded prior to 1995 as inclusion of earlier check gaugings would significantly increase our confidence in the rating at higher flows. Secondly, a continued programme of flow gauging at the site would help both define the high flow rating and to confirm the stability of the rating (particularly given the apparent depositional bar). Finally, a hydraulic model of this reach of the

watercourse would help to assess the potential for bypassing of the structure. It is likely that a hydraulic model would be able to provide a good estimation of the amount of bypassing at any given flow. However, it may be unable to relate this to level recorded at the gauge, particularly at high flows as it will be unable to reliably model the occurrence of a hydraulic jump. A hydraulic model will however provide a robust tool for improving the rating into moderately high flows (before the occurrence of supercritical flow through the structure). Given the possibility of extensive bypassing at this location we recommend developing a linked 1D-2D hydraulic model. The hydraulic model should be extended approximately 500m upstream of the gauge location in order accurately represent floodplain flow and potential bypass routes. Downstream of the gauge the model must be extended beyond one backwater length (around 300m) to ensure accurate representation of the hydraulic controls at the gauge site. However it must also be extended downstream sufficiently far that bypassing flows are able to rejoin the main channel. In order for this to occur we plan to extend the model approximately 450m downstream of the gauge. As well as these open channel sections both the upstream and downstream (gauge location) faces of the bridge should be surveyed. In total it is anticipated that nine surveyed sections will be required to accurately develop a hydraulic model of this reach. If possible it would also be beneficial if the surveyors are able to pick up bank levels along the right bank of the study reach (where most bypassing may occur).

Introduction to Rainfall event summary sheets

This appendix provides results from analysis of rainfall events. Most of the analysis has been carried out using daily rainfall data as there are very few sub-daily gauges in the study area. However, some more simplified sheets show analysis of sub-daily data to aid in understanding the characteristics of short-duration rainfall events.

Information provided in the summary sheets

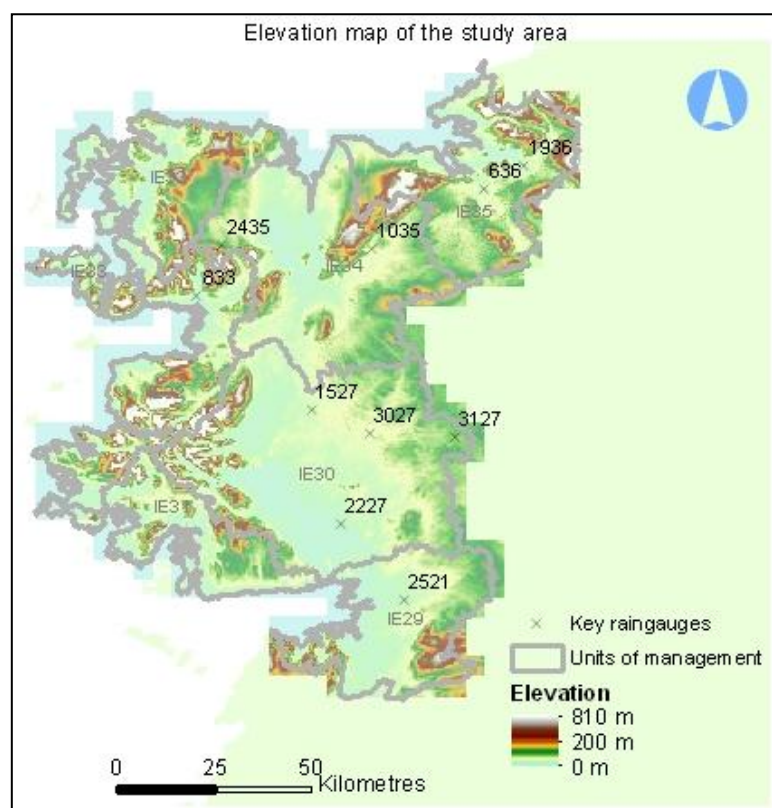


Map of rainfall depths

The map shows the total accumulated rainfall for the range of dates given in the heading of the sheet. Gauges included on the map are those that are within or near to catchments in the initial list of Areas for Further Assessment (AFAs) provided at the start of the project. A small number of extra AFAs in other catchments were identified during the flood risk review, but this was completed after the rainfall analysis had been carried out.

The map identifies ten key gauges, spread throughout the study area, for which long records are available.

In interpreting the map it is important to bear in mind the general tendency for higher rainfall in the upland areas. The map below shows the topography of the area in relation to the key rain gauge locations.



Time series

Series of daily rainfalls at each of the key gauges for which data is available

Commentary

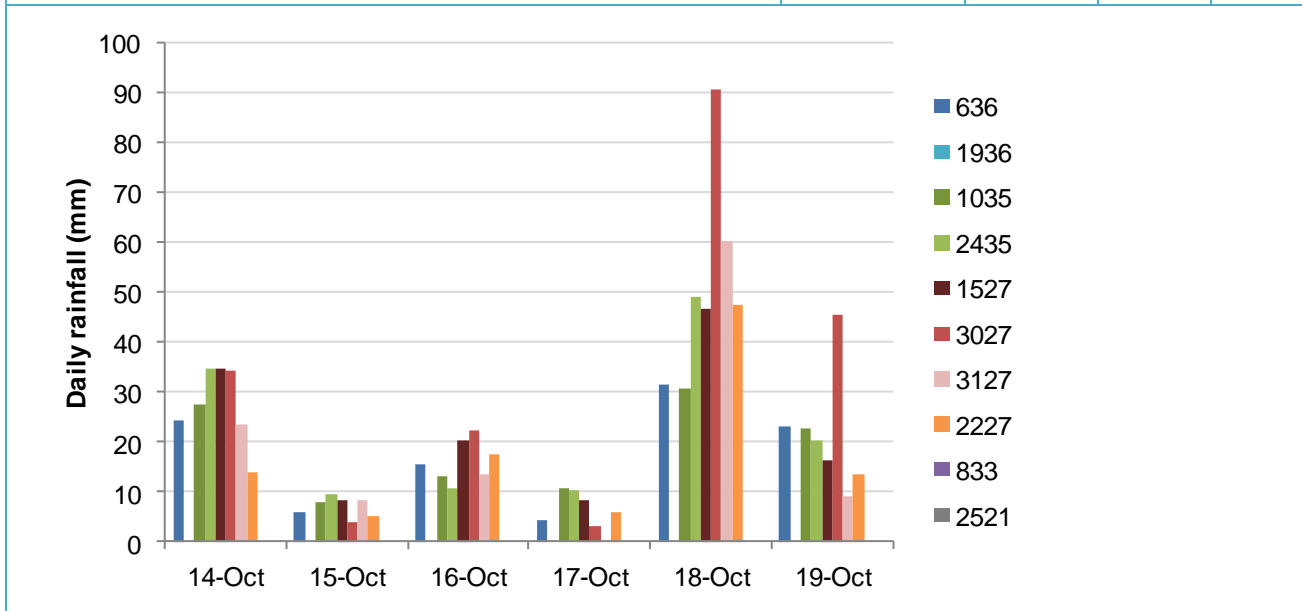
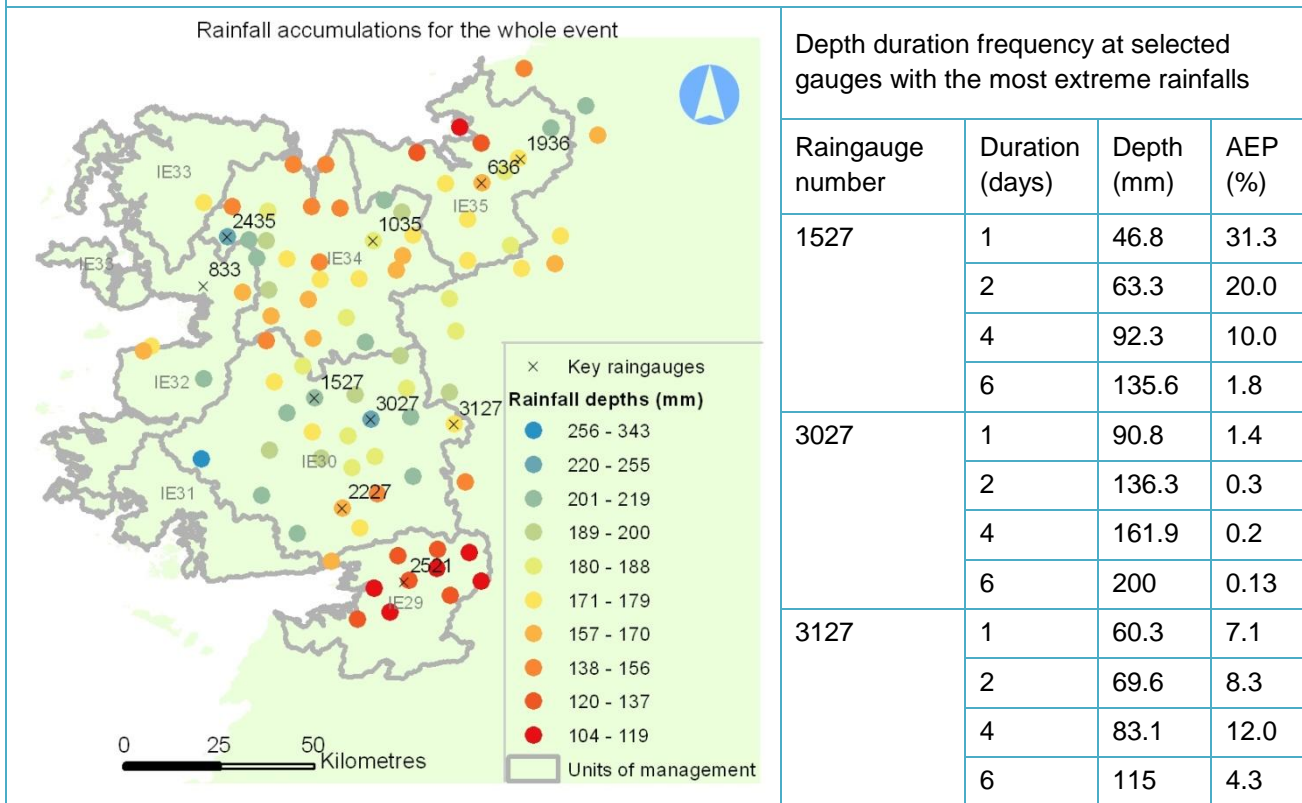
Comments on the characteristics of the event, including any synoptic information available from Met Éireann reports.

Depth duration frequency analysis

Table of rainfall depths and corresponding annual exceedance probabilities (AEPs) for the maximum rainfall accumulated over a range of durations at selected rain gauges. The gauges included in this analysis are those where the rainfall was most notable, i.e. the AEPs were the lowest. The durations have been chosen to be appropriate to the nature of the event, with up to 14 days used for prolonged periods of rainfall. AEPs are calculated from the FSU rainfall frequency statistics.

Rainfall event summary sheet

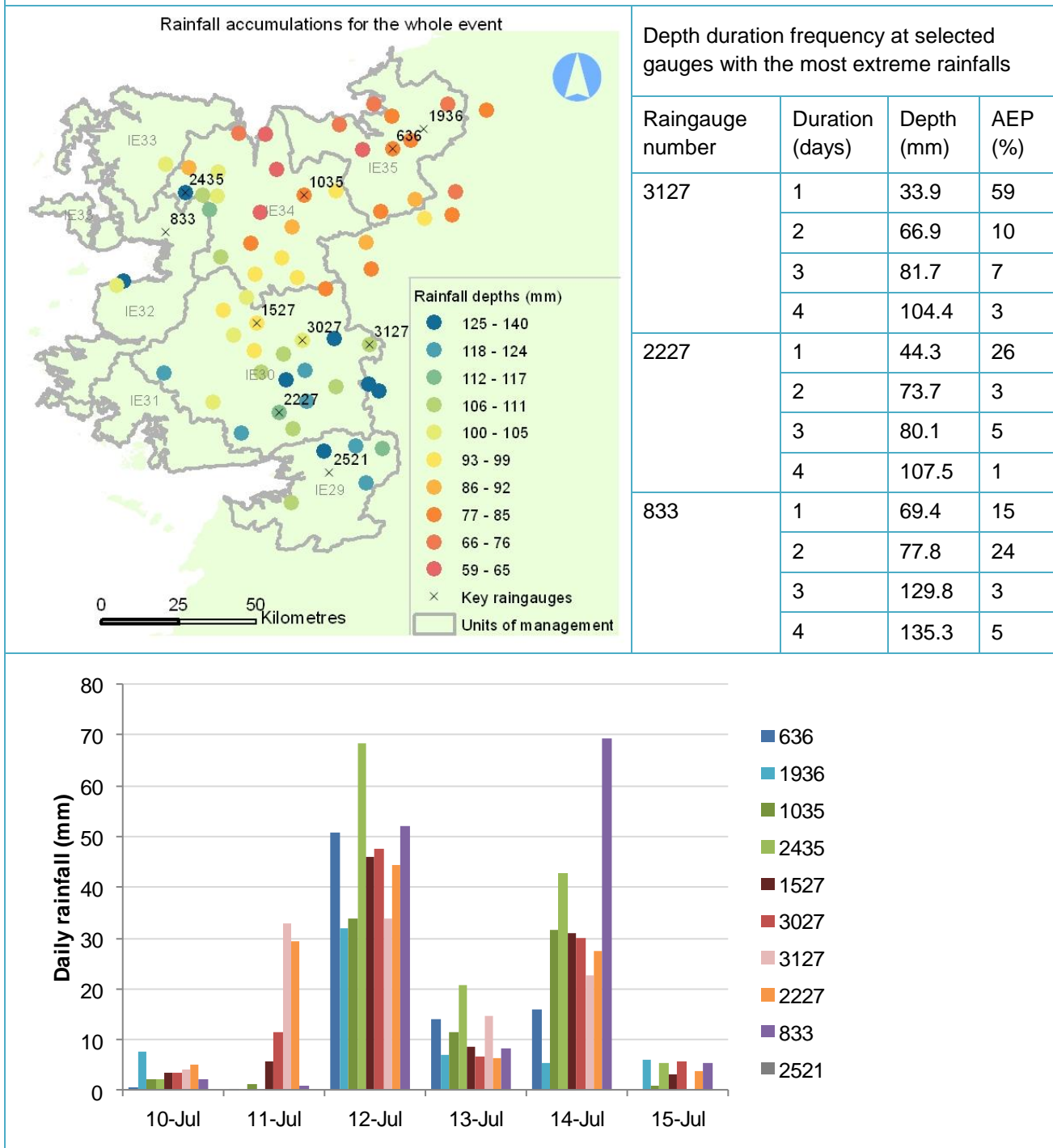
14 to 19 October 1954



Several days of rainfall culminated in large daily totals on 18 October 1954. The rain affected the whole of the Western RBD although it was most severe in hydrometric area 30, with an AEP below 1% at gauge 3027, Milltown (between Tuam and Claremorris), for durations over 1 day. For a duration of 6 days, the AEP at Milltown was as low as 0.13% (a return period of 800 years).

Rainfall event summary sheet

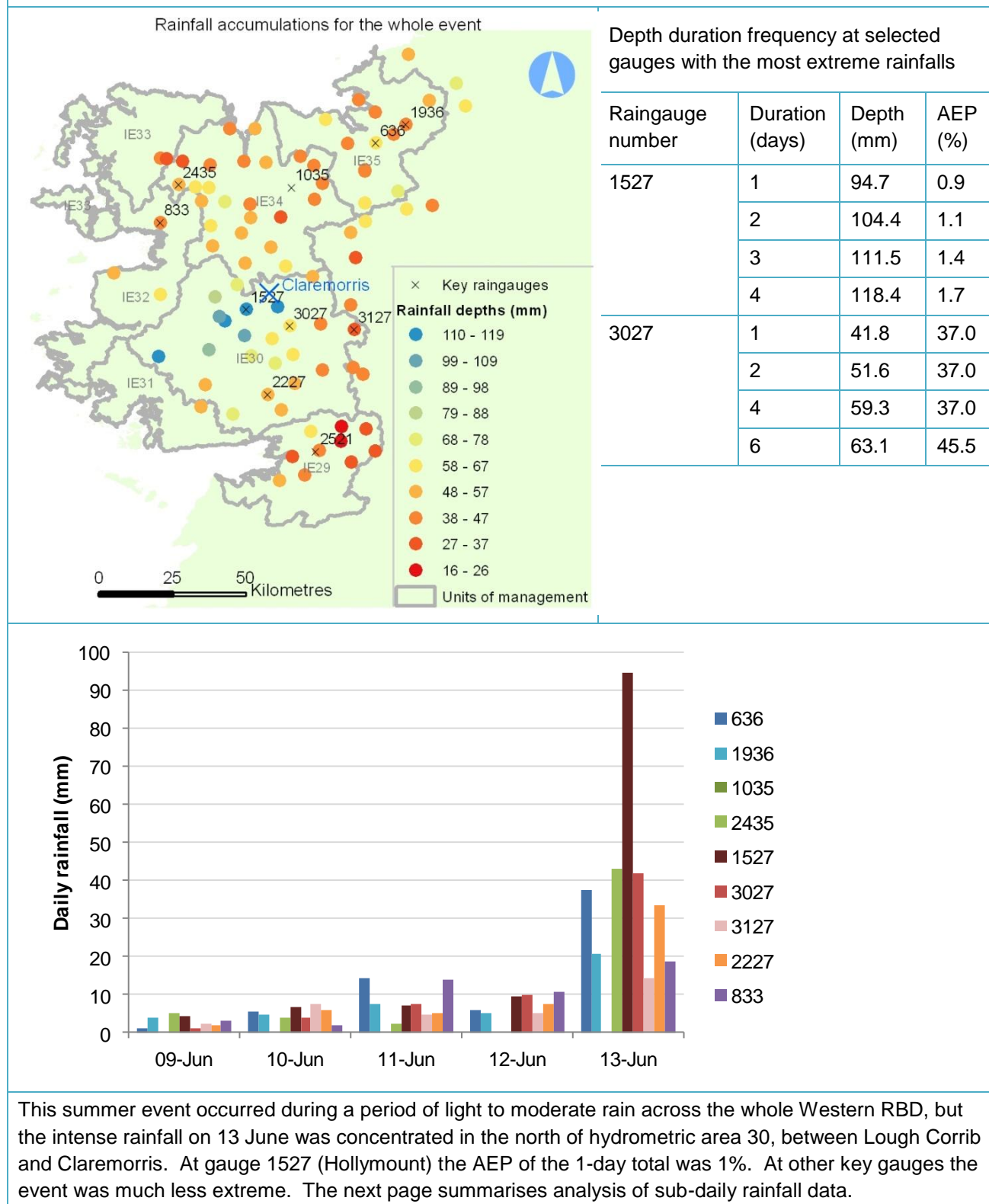
10 to 15 July 1961



This summer event affected the whole of the Western RBD, although the largest 6-day accumulations were in hydrometric areas 29 and 30, in the area between Athenry and Claremorris. The majority of the rainfall fell on 12 and 14 July. AEPs were as low as 1% over a duration of 4 days.

Rainfall event summary sheet

10 to 14 June 1964



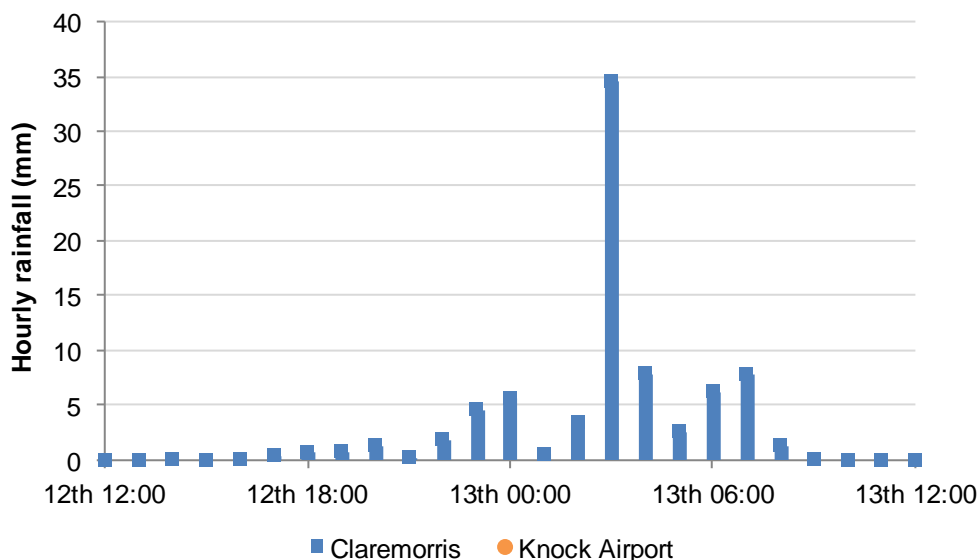
Analysis of hourly rainfall data

The short, intense nature of this event indicates that analysis of sub-daily rainfall data is worthwhile. Data is available from one gauge in the study area, Claremorris (see the map on the previous page).

Depth duration frequency at Claremorris

| Duration (hours) | Depth (mm) | AEP (%) |
|------------------|------------|---------|
| 1 | 34.6 | 1.2 |
| 2 | 42.5 | 1.2 |
| 3 | 55.1 | 0.7 |
| 4 | 61.4 | 0.6 |
| 6 | 72.6 | 0.5 |
| 9 | 83.3 | <0.5 |
| 12 | 86.7 | 0.6 |

Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.



During an event which lasted around 10 hours at Claremorris there was an exceptionally heavy burst of rainfall, 34.6mm in 1 hour between 0200 and 0300 on 13 June. Over all accumulation durations from 1 to 24 hours this is the highest rainfall recorded to date at Claremorris (1950-2010).

The AEP of the 1-hour total was 1.2%, i.e. a return period of 80 years. Over the full duration of the event, the AEP was just under 0.5, i.e. a return period over 200 years. This is consistent with the analysis of the daily rainfall data in the vicinity, for example at gauge 1527. It is likely (although hard to be sure without any other recording raingauge data) that the duration of the event was similar at other nearby locations which recorded large daily totals. Rainfall of this intensity is likely to have resulted in local flooding.

Sub-daily rainfall event summary sheet

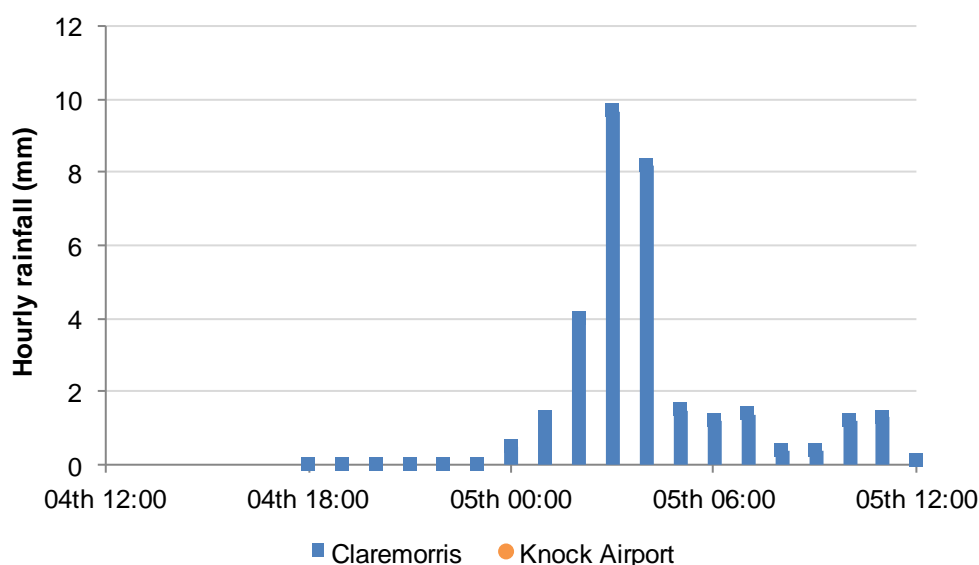
5 October 1964

Hourly rainfall data is available from one gauge in the study area, Claremorris.

Depth duration frequency at Claremorris

| Duration (hours) | Depth (mm) | AEP (%) |
|------------------|------------|---------|
| 1 | 9.7 | High |
| 2 | 17.9 | 31.1 |
| 3 | 21.9 | 26.5 |
| 4 | 23.4 | 29.7 |
| 6 | 24.7 | 39.0 |
| 9 | 27.3 | 44.8 |
| 12 | 29.3 | 49.5 |

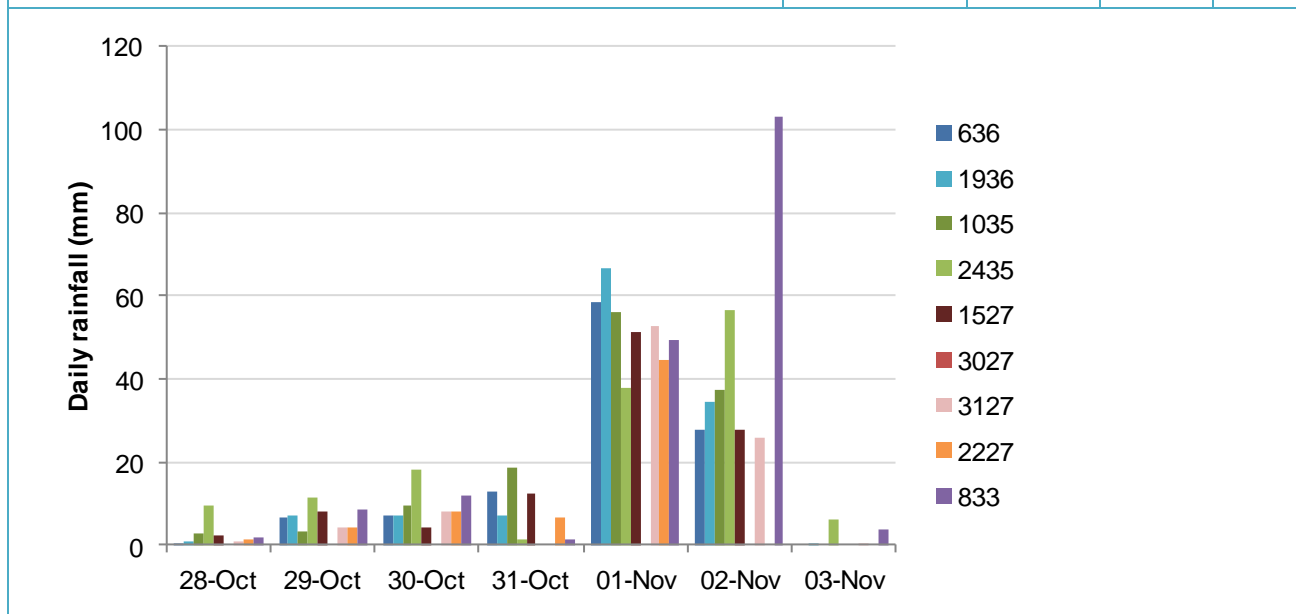
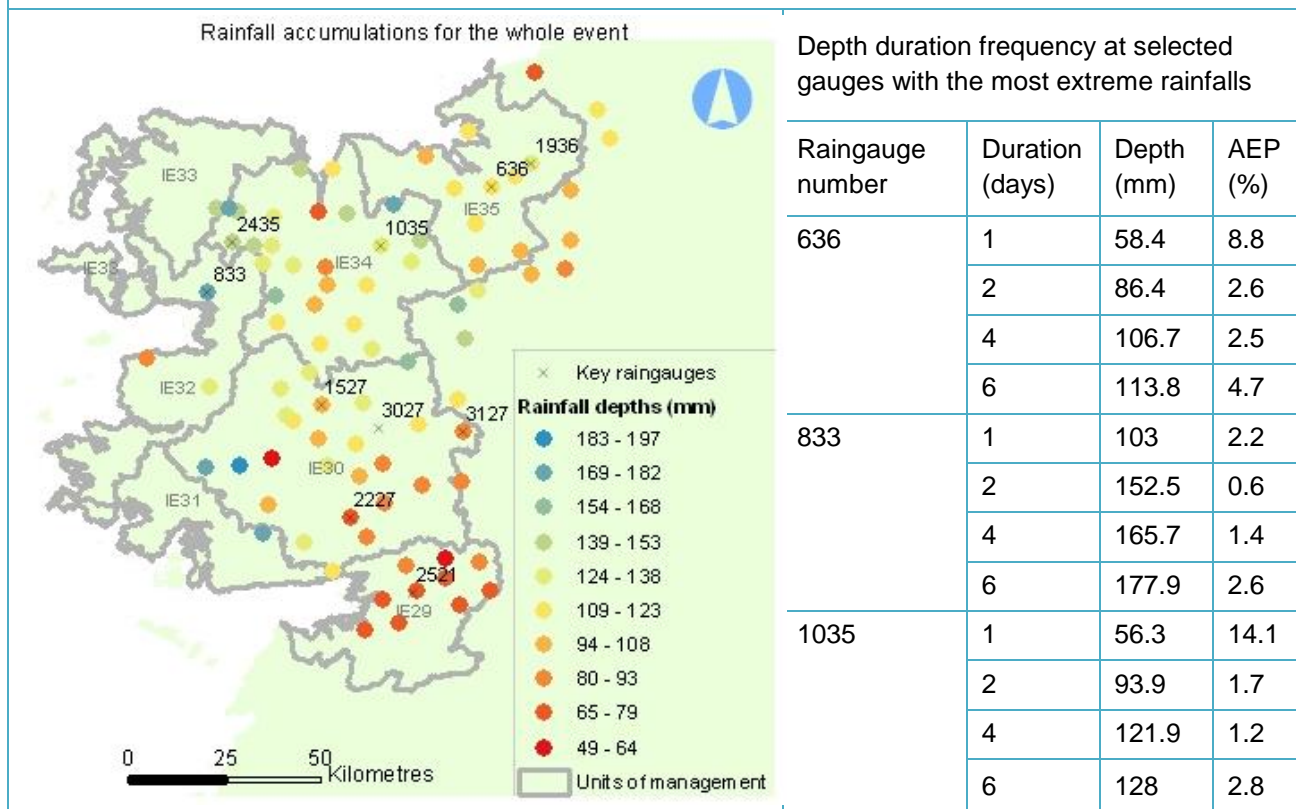
Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.



Heavy rainfall was recorded in the early hours of 5 October. Over a duration of 2-4 hours the AEP was around 30%, i.e. a return period of 3 years.

Rainfall event summary sheet

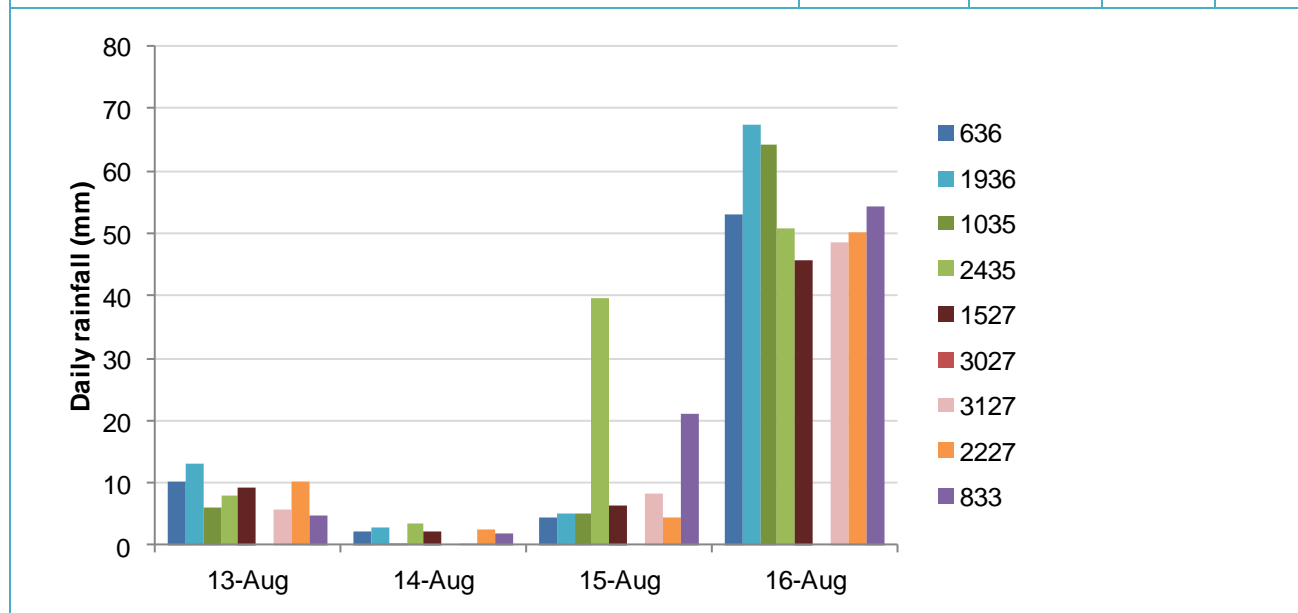
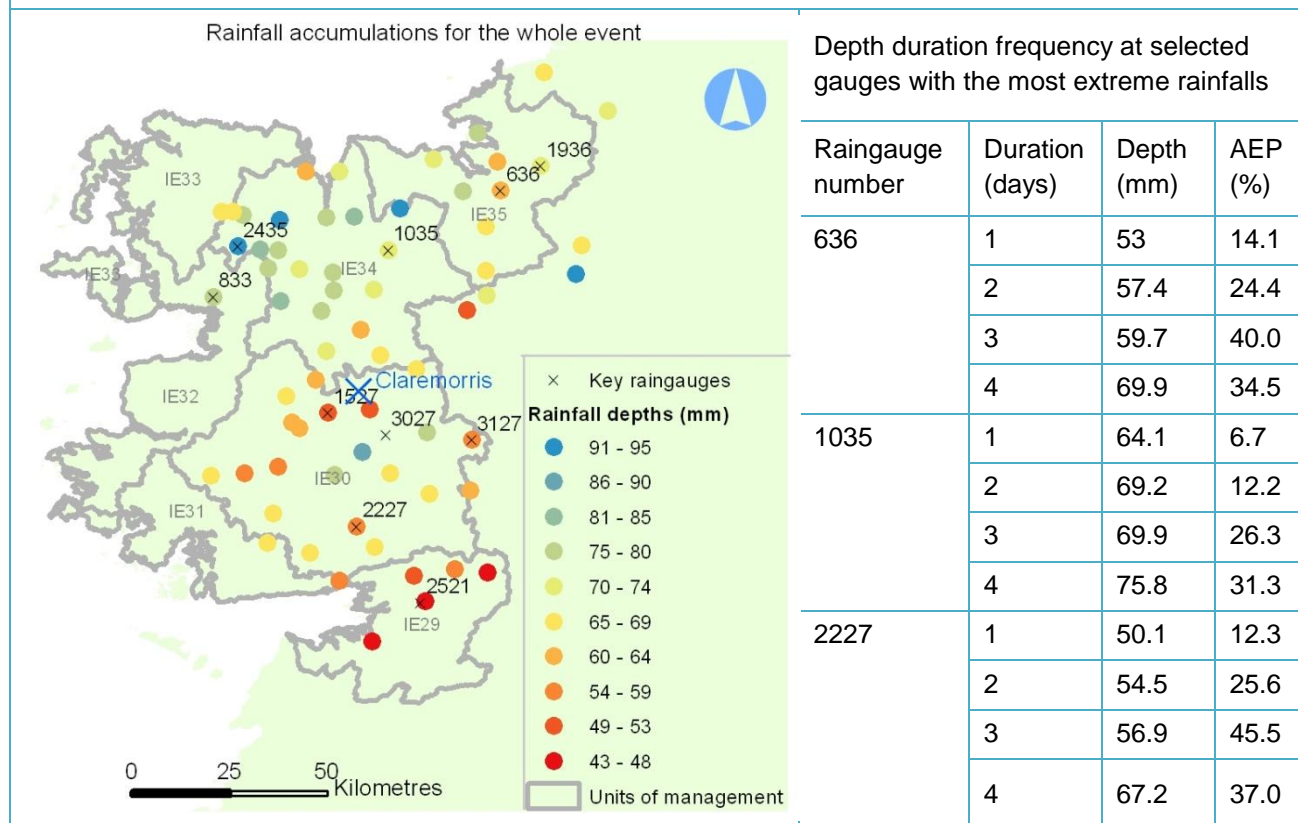
29 October to 2 November 1968



Several days of moderate rainfall in late October were followed by two days of heavy rainfall, 1 and 2 November, affecting all parts of the Western RBD although with much larger totals to the west and north.. Rainfall rarities were most notable over a duration of 2-4 days, with AEPs as low as 0.6% (a return period of 160 years) at Newport, north of Westport.

Rainfall event summary sheet

13 to 16 August 1970



Moderate rainfall on 13 and 15 August was followed by a heavy fall on 16th. The rainfall was heaviest in hydrometric areas 32 and 34 and the northern part of area 30. High rainfall totals were recorded in the Nephin Beg mountains of Mayo (e.g. at gauge 2435) but the event rarity was most severe further east. At gauge 1035 (Aclare, north of Swinford) the 1-day AEP was 7%, a return period of 15 years.

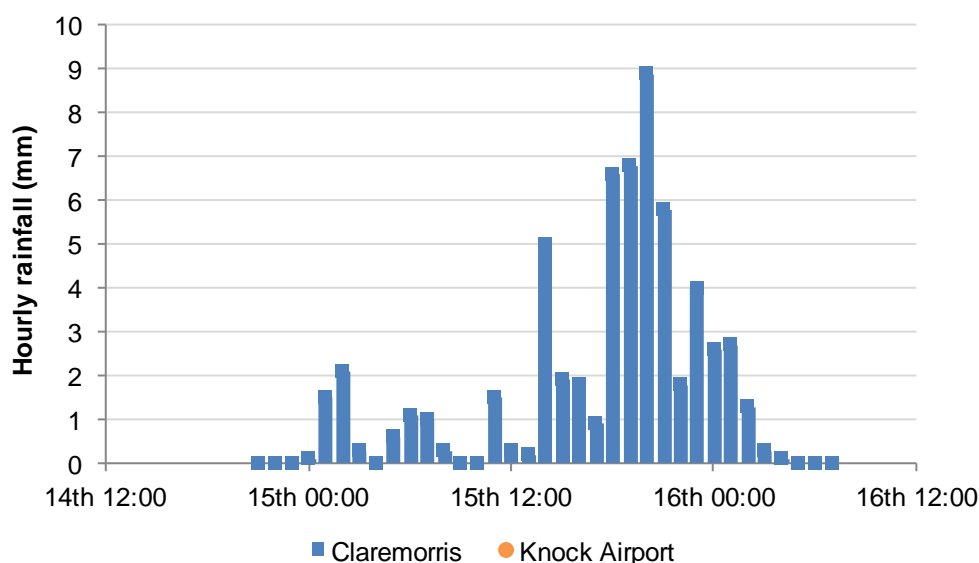
Analysis of hourly rainfall data

The short, intense nature of this event indicates that analysis of sub-daily rainfall data is worthwhile. Data is available from one gauge in the study area, Claremorris (shown on the map on the last page).

Depth duration frequency at Claremorris

| Duration (hours) | Depth (mm) | AEP (%) |
|------------------|------------|---------|
| 1 | 15.7 | 22.0 |
| 2 | 22.3 | 15.5 |
| 3 | 28.1 | 11.2 |
| 4 | 29.9 | 12.8 |
| 6 | 36.5 | 10.1 |
| 9 | 43.5 | 8.7 |
| 12 | 50.1 | 7.2 |

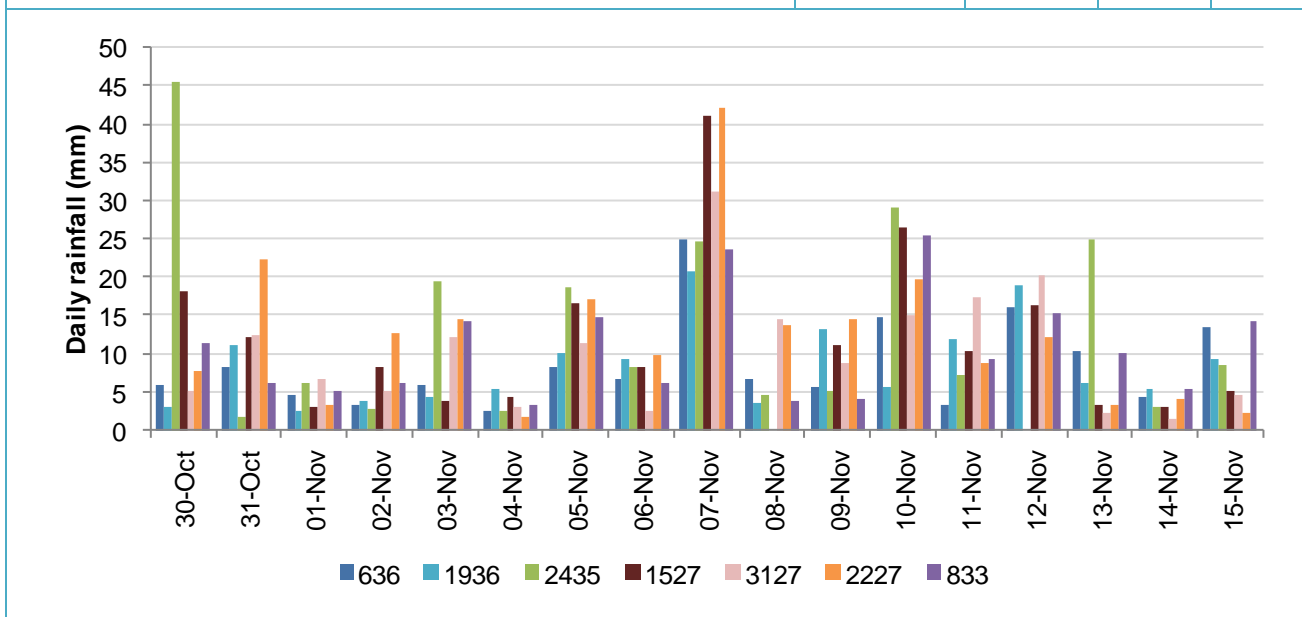
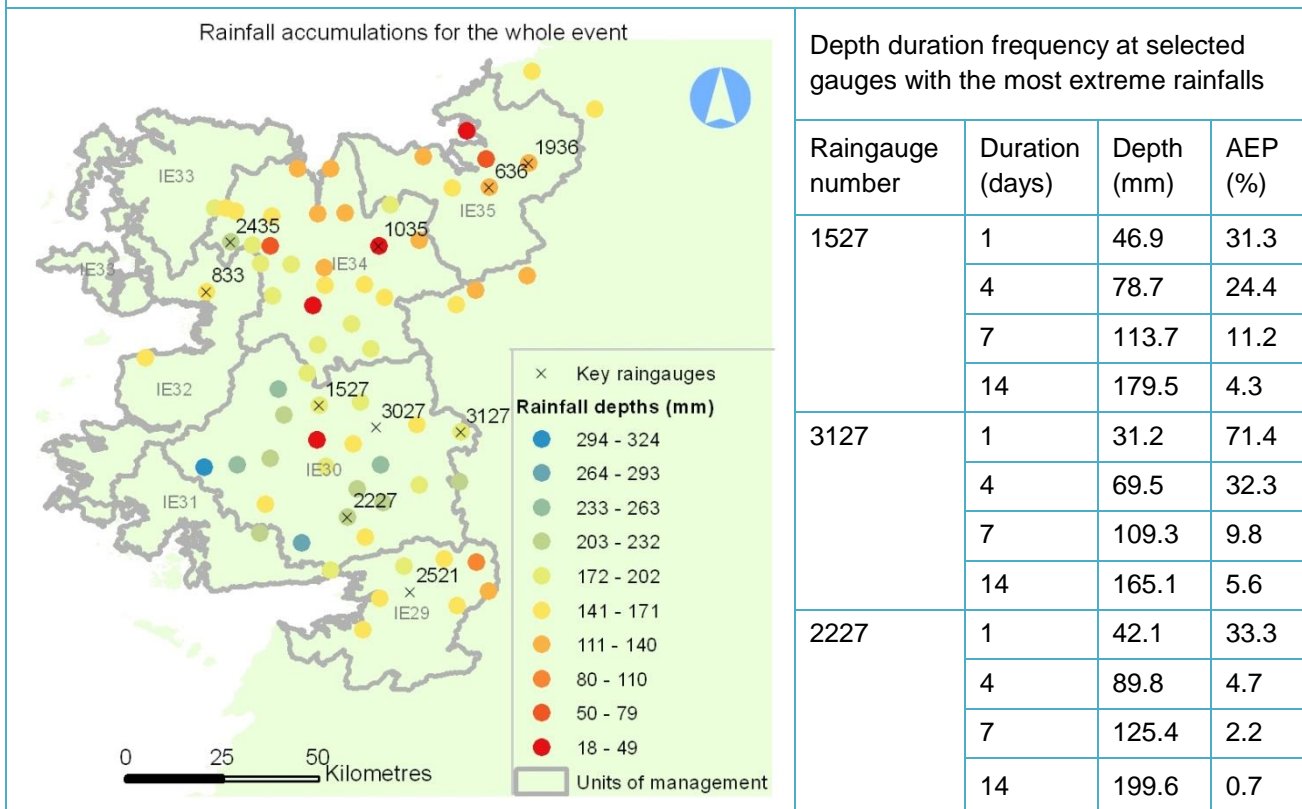
Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.



After light rain on the morning of 15 August, heavy rain fell during the afternoon and overnight into 16 August. The AEPs indicate that the rainfall was not particularly extreme at Claremorris. It can be seen from the map that the rainfall was heavier further north and also to the south.

Rainfall event summary sheet

29 October to 14 November 1977



Prolonged rainfall frequently occurs in late Autumn. In 1977 there was some rain every day from late September to late November. The highest falls were in early November, particularly over hydrometric area 30 and the south of 34. The map shows a few raingauges in this area with much lower rain but this is probably due to missing data. Further north, around Sligo, there was much less rain. The maximum accumulation over a 2-week period was not particularly extreme at most gauges, but at 2227 (Carndolla, between Galway and Headford) the AEP was as low as 0.7% (a return period of 150 years).

Sub-daily rainfall event summary sheet

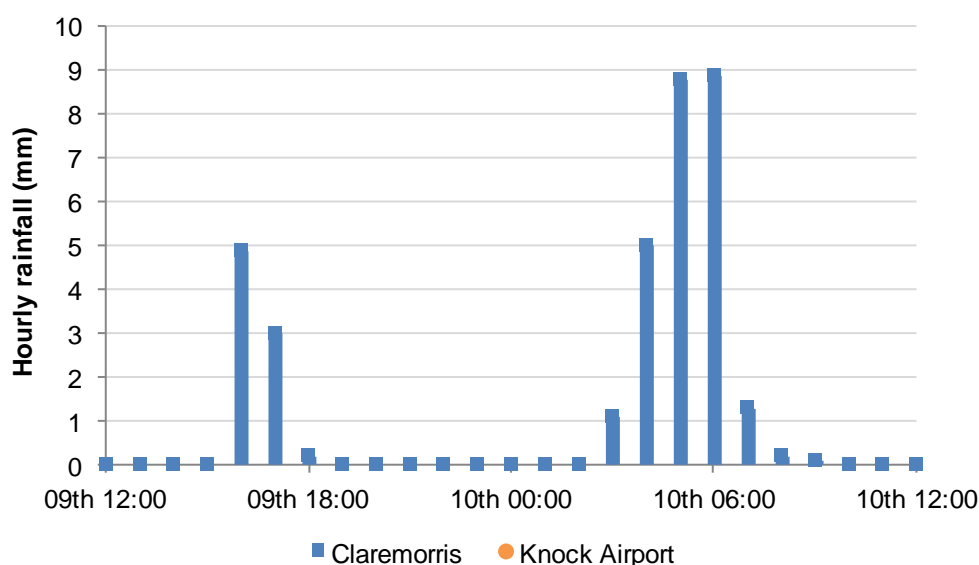
10 September 1981

Hourly rainfall data is available from one gauge in the study area, Claremorris.

Depth duration frequency at Claremorris

| Duration (hours) | Depth (mm) | AEP (%) |
|------------------|------------|---------|
| 1 | 8.9 | High |
| 2 | 17.7 | 32.1 |
| 3 | 22.7 | 23.7 |
| 4 | 24 | 27.5 |
| 6 | 25.1 | 37.3 |
| 9 | 25.4 | High |
| 12 | 25.4 | High |

Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.



After a brief shower on the afternoon of 9 September, heavy rainfall was recorded early in the morning on 10 September. The lowest AEP was for the 3-hour accumulation of 22.7mm, which has an AEP of 24%, i.e. return period of 4 years.

Appendix C – Rainfall analysis

Sub-daily rainfall event summary sheet

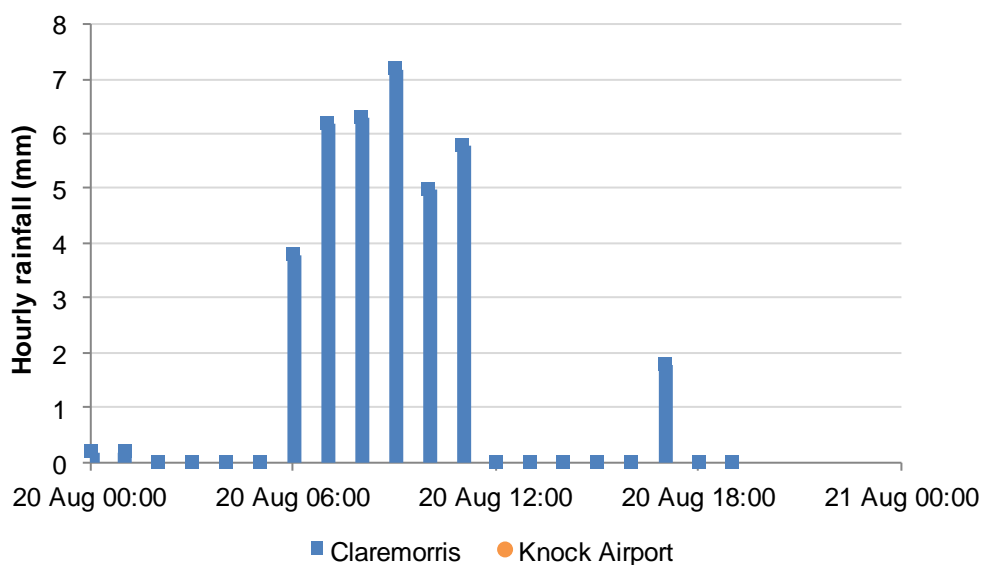
20 August 1987

Hourly rainfall data is available from one gauge in the study area, Claremorris.

Depth duration frequency at Claremorris

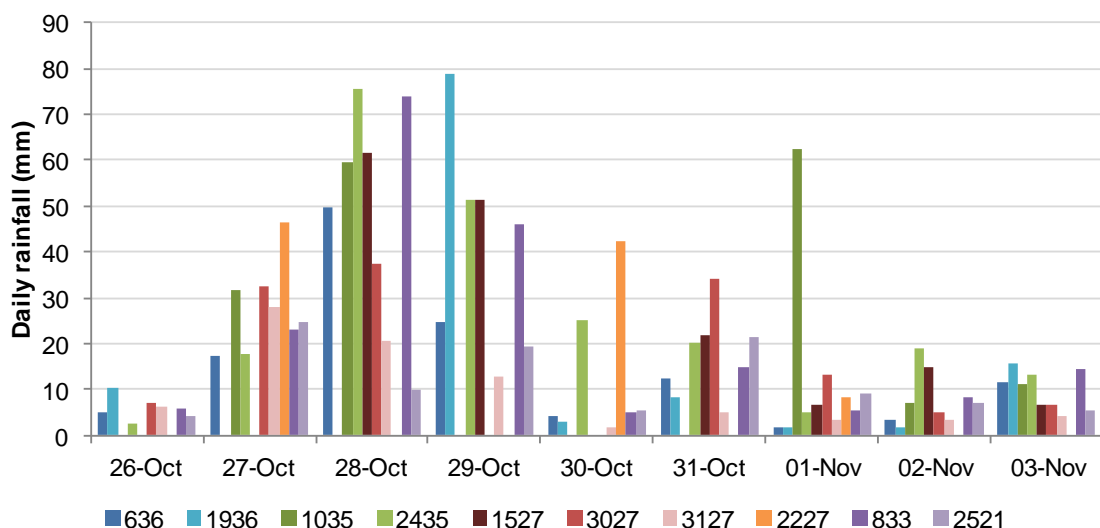
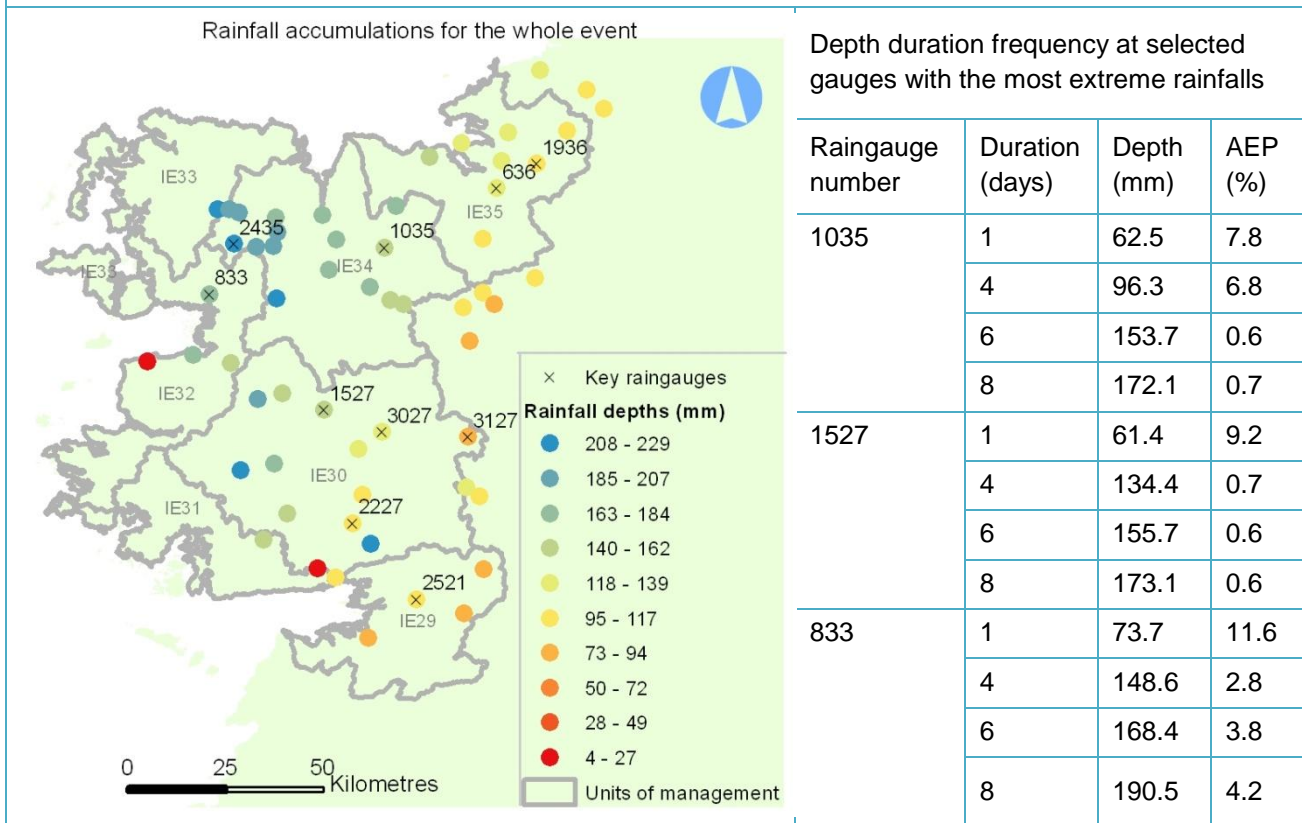
| Duration (hours) | Depth (mm) | AEP (%) |
|------------------|------------|---------|
| 1 | 7.2 | High |
| 2 | 13.5 | High |
| 3 | 19.7 | 36.2 |
| 4 | 24.7 | 25.1 |
| 6 | 34.3 | 13.0 |
| 9 | 34.3 | 22.1 |
| 12 | 36.1 | 26.4 |

Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.



Warm and humid weather, associated with southerly winds, brought periods of heavy rainfall during mid-August. This short rainfall event lasted for 6 hours on the morning of 20 August. The 6-hour accumulation at Claremorris had an AEP of 13%, i.e. a return period of 8 years.

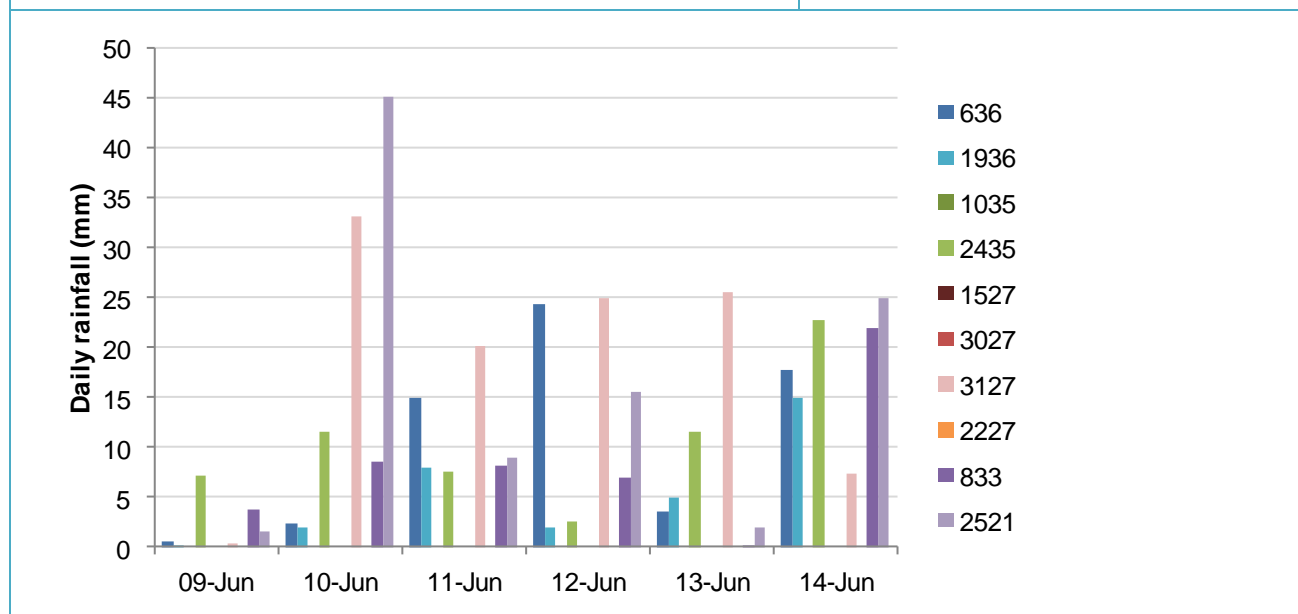
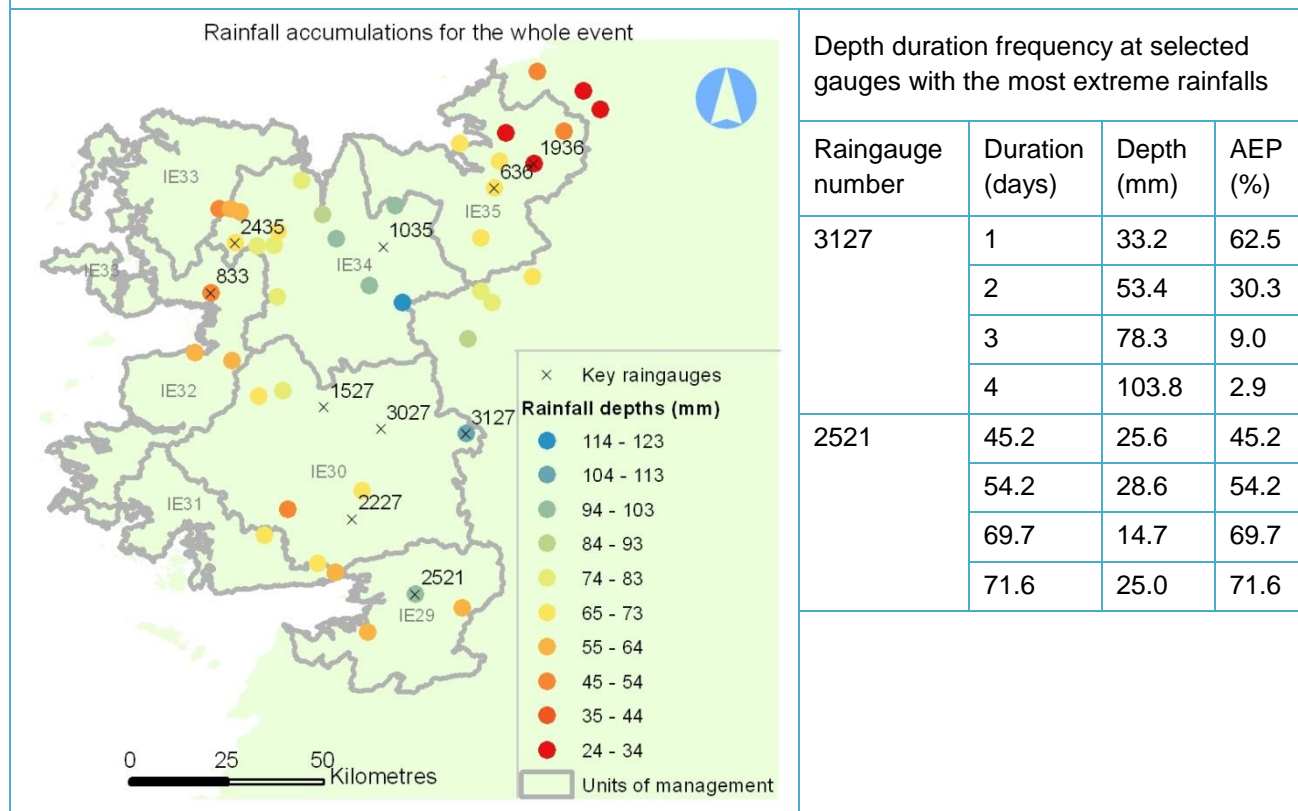
Rainfall event summary sheet

26 October to 2 November 1989

Rainfall affected all of the study area from 5 October to mid-November 1989 and was most severe in late October when a depression approached the extreme SW of Ireland and then moved east, resulting in a slow-moving band of rain associated with a warm front. The largest falls were over the Galway and Mayo mountains and over much of hydrometric areas 30, 32, 33 and 34. The two red spots on the map are probably due to periods of missing data. At Belmullet (NW corner of County Mayo) it was the wettest October since records began, with 129mm recorded in a 36-hour period. AEPs were below 1% for accumulations over several days at gauges 1035 (Aclare) and 1527 (Holymount).

Rainfall event summary sheet

9 to 14 June 1993



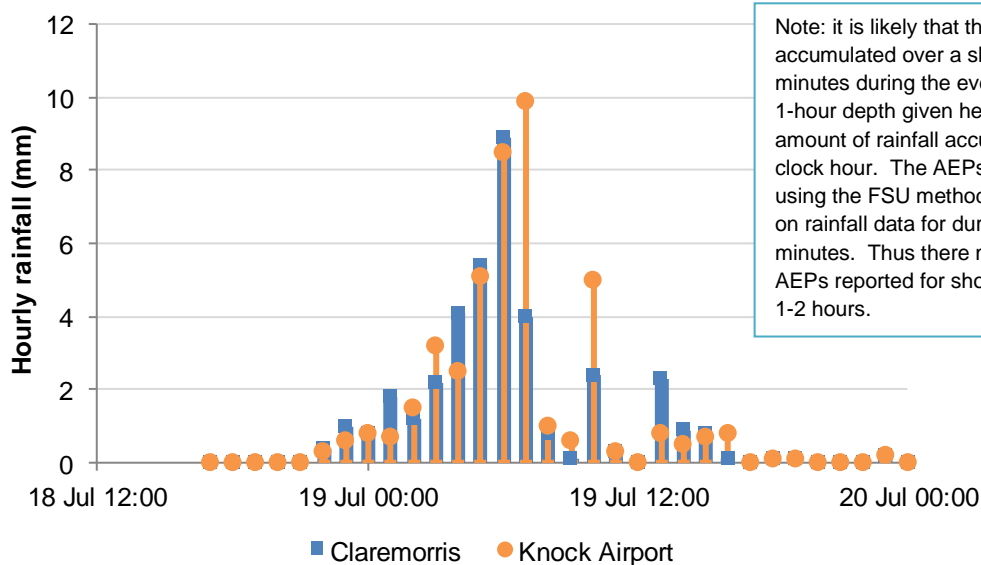
Note that data is missing from several of the key gauges during this event. Rain was caused by a cool northerly airflow due to a depression centred over England and Wales. On 11 June there was very heavy rain in the east midlands and north of Ireland. In the Western RBD, the rainfall over this period was heaviest inland, in the east of hydrometric areas 29, 30 and 34. At gauge 3127 (Glenamaddy, north-east of Tuam) there were four days of notable rainfall, totalling 104mm, with an AEP of 3% over the 4 days (a return period of 30 years).

Sub-daily rainfall event summary sheet

19 July 1998

Hourly rainfall data is available from two gauges in the study area, Claremorris and Knock Airport.

| Depth duration frequency at Claremorris | | | Depth duration frequency at Knock Airport | | |
|---|------------|---------|---|------------|---------|
| Duration (hours) | Depth (mm) | AEP (%) | Duration (hours) | Depth (mm) | AEP (%) |
| 1 | 8.9 | High | 1 | 9.9 | High |
| 2 | 14.3 | High | 2 | 18.4 | 33.1 |
| 3 | 18.4 | 43.4 | 3 | 23.5 | 24.9 |
| 4 | 22.4 | 33.7 | 4 | 26 | 25.1 |
| 6 | 25.8 | 34.4 | 6 | 30.7 | 23.4 |
| 9 | 29.4 | 36.2 | 9 | 37.3 | 19.8 |
| 12 | 32.7 | 36.2 | 12 | 39.4 | 23.2 |



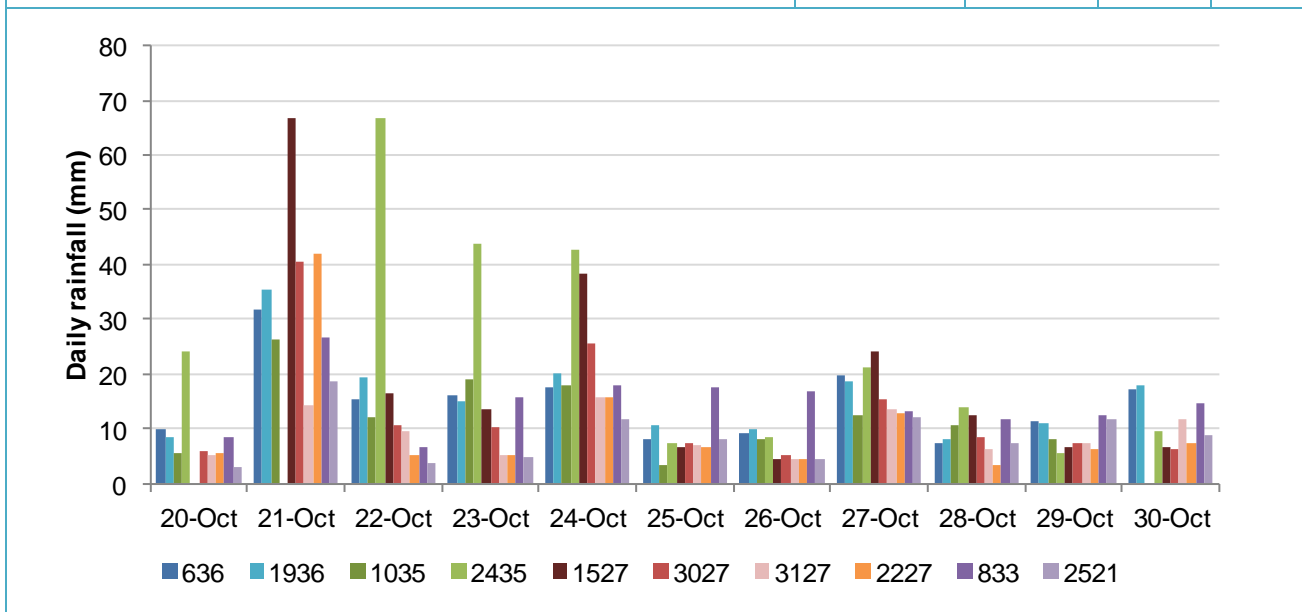
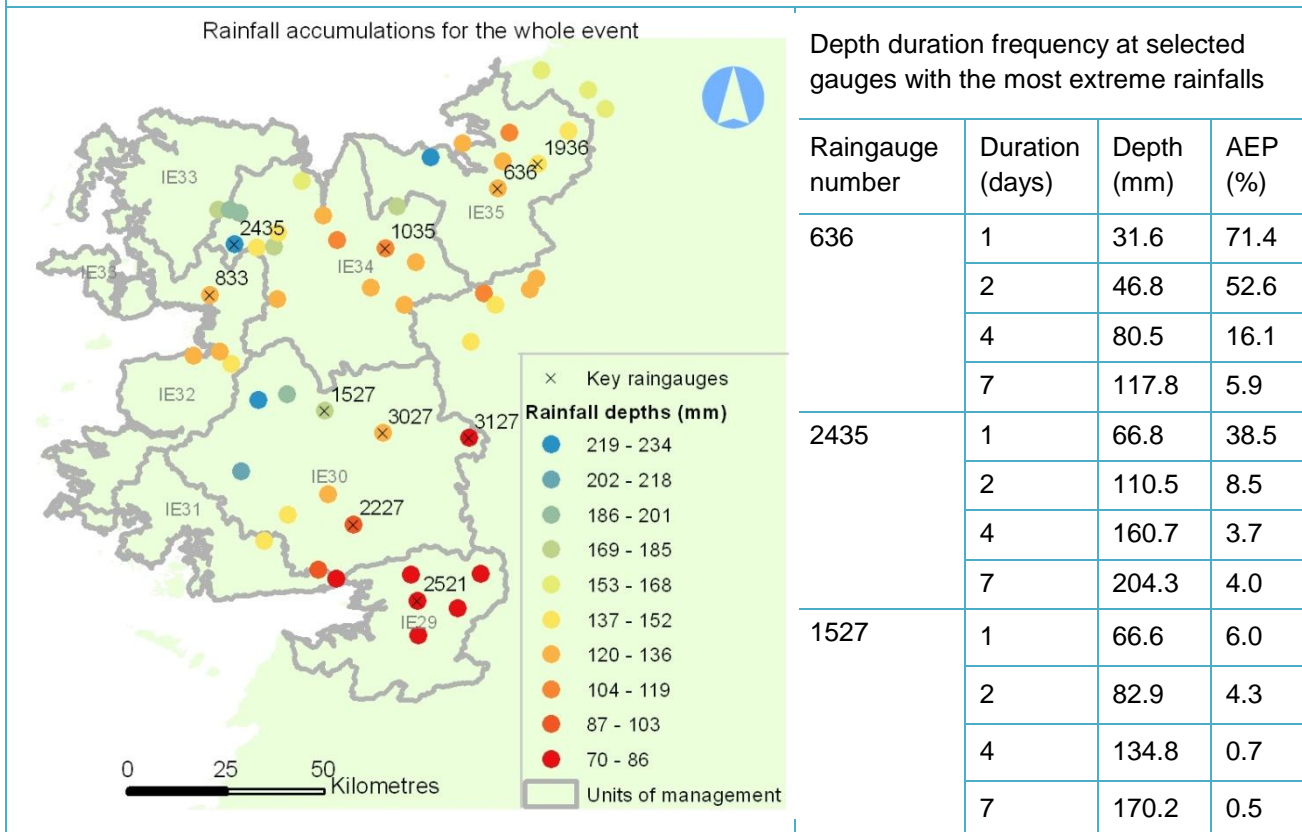
Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.

19 July was a cloudy day with close to normal temperatures. There were spells of rain, some heavy and thunder, across much of Ireland apart from the east coast.

At both raingauges, the event started around midnight on 19 July and continued through the morning. The heaviest rainfall was recorded from 0400 to 0700. The depth of rainfall was similar at the two gauges, and the AEPs indicated that the rainfall was not particularly extreme: typical AEPs were 30-40% at Claremorris and 20-25% (i.e. return periods of 4-5 years) at Knock Airport.

Rainfall event summary sheet

20 to 28 October 1998



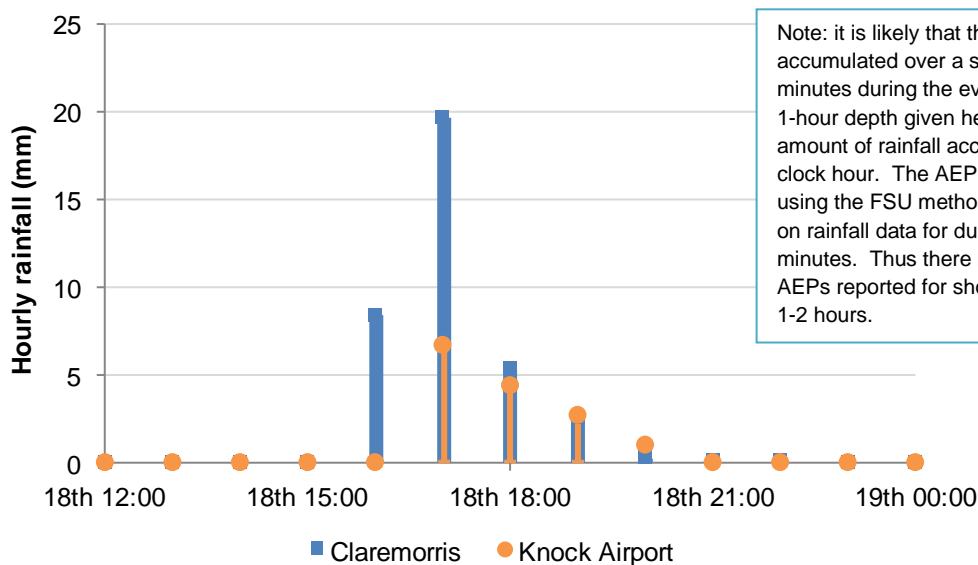
On 20-21 October a deepening depression moved northwards to the west of Ireland bringing heavy frontal rainfall driven by south-easterly gales. There was more widespread and heavier rainfall on 25th. Total October rainfall was near-normal for the western RBD whereas in the SW of Ireland it was the wettest October since 1940. The event impacted all of the Western RBD although totals were lower in hydrometric area 29. It was most extreme at gauge 1527, Hollymount, where the AEP was as low as 0.5% over 1 week of rain – although this may be exaggerated by a possible 2-day accumulation of rain recorded on 21 Oct.

Sub-daily rainfall event summary sheet

18 August 2000

Hourly rainfall data is available from two gauges in the study area, Claremorris and Knock Airport.

| Depth duration frequency at Claremorris | | | Depth duration frequency at Knock Airport | | |
|---|------------|---------|---|------------|---------|
| Duration (hours) | Depth (mm) | AEP (%) | Duration (hours) | Depth (mm) | AEP (%) |
| 1 | 19.7 | 10.2 | 1 | 6.7 | High |
| 2 | 28.1 | 6.5 | 2 | 11.1 | High |
| 3 | 33.5 | 5.5 | 3 | 13.8 | High |
| 4 | 36.1 | 6.0 | 4 | 14.8 | High |
| 6 | 36.5 | 10.1 | 6 | 14.8 | High |
| 9 | 36.6 | 17.5 | 9 | 14.8 | High |
| 12 | 36.6 | 25.2 | 12 | 14.8 | High |

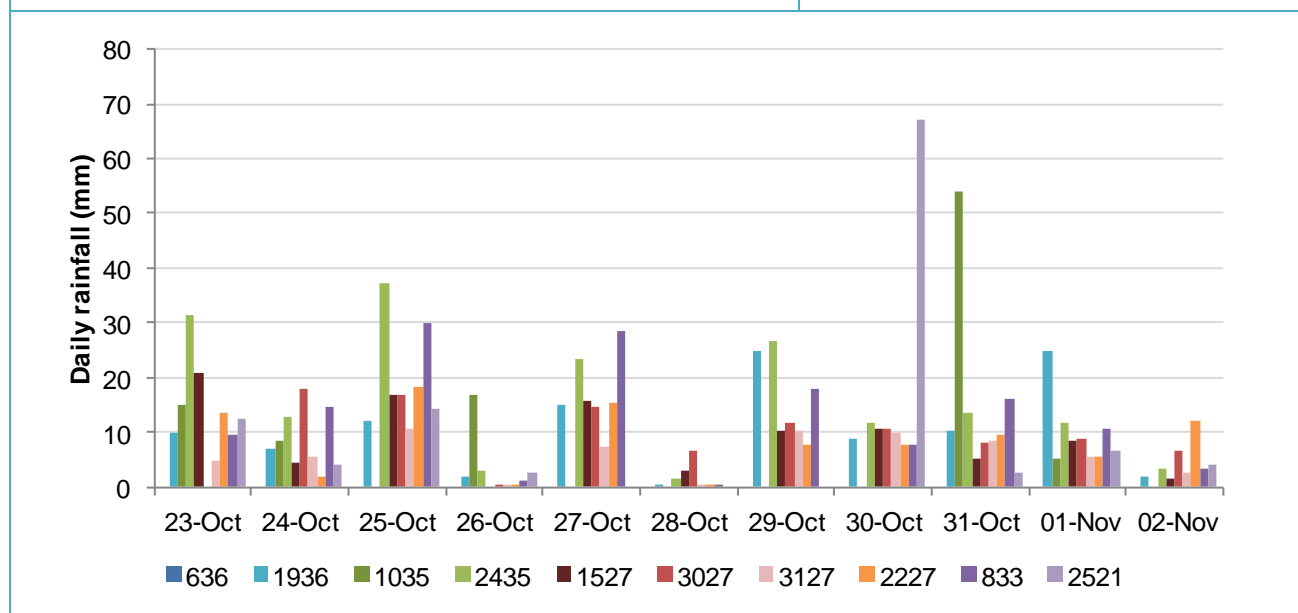
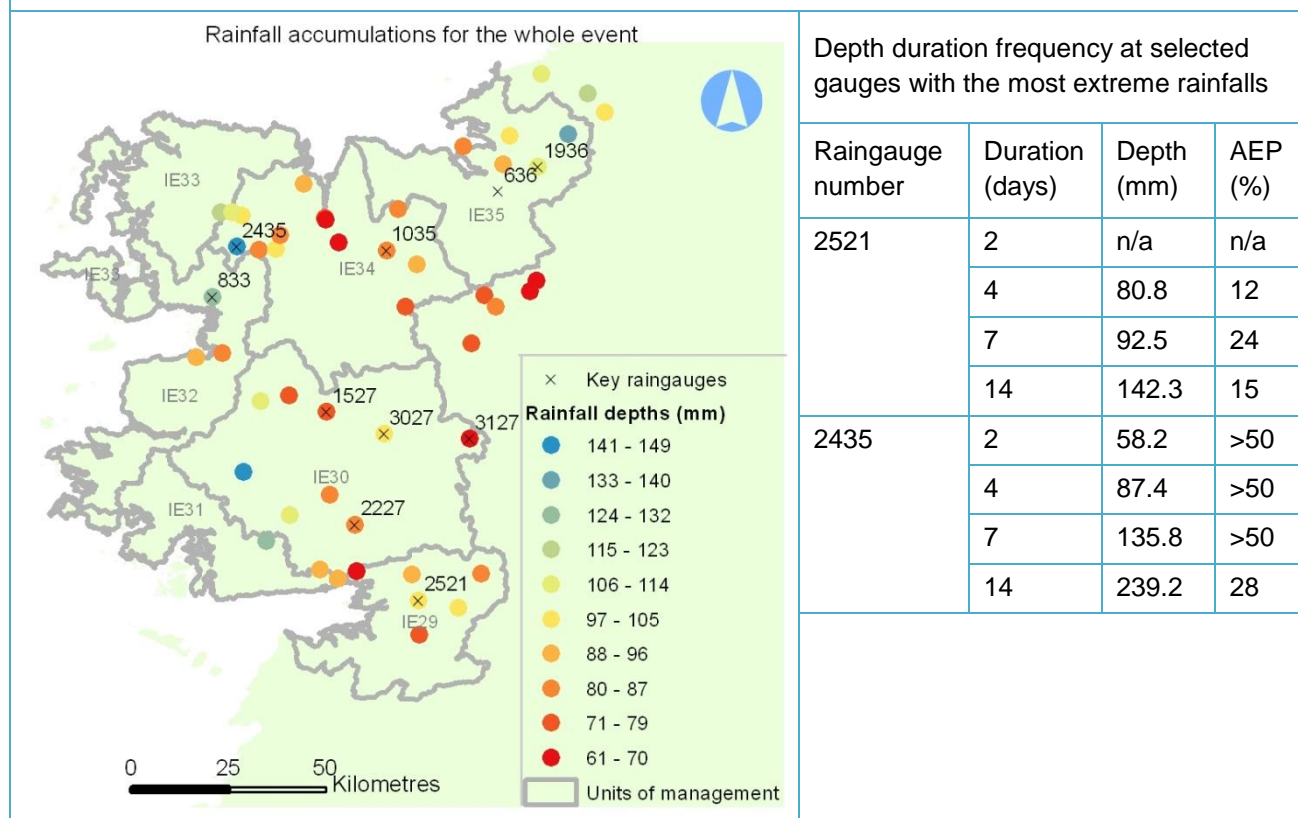


Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.

August 2000 was warm and there were frequent thunderstorms between 16th and 21st. On 18th thunder showers were confined to the north-west of Ireland, with temperatures between 16° and 19° C.

This event was a brief burst of rainfall which lasted for a few hours in the late afternoon and early evening of 18 August. At Knock Airport the totals were not noteworthy but at Claremorris the rainfall was intense, resulting in AEPs around 6% for durations 2-4 hours (i.e. return periods around 17 years).

Rainfall event summary sheet

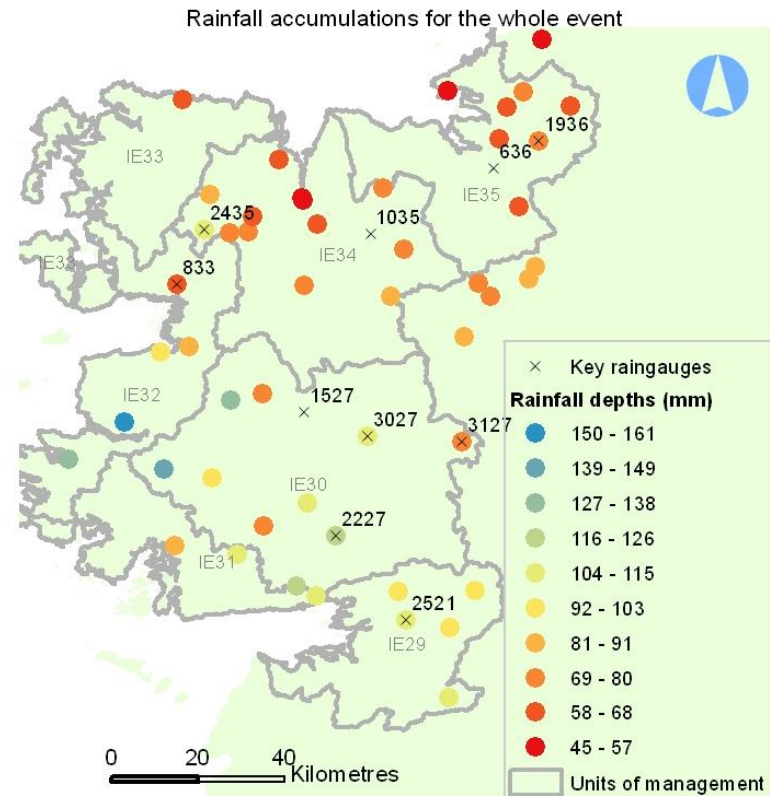
24 October to 2 November 2000

This event affected all of the Western RBD. A succession of Atlantic depressions brought rain almost every day from late August to mid December 2000. The highest totals were observed in late Oct and early Nov, although the event was not particularly severe at any of the key gauges analysed. The lowest AEP was at gauge 2521, Craughwell. In England and Wales the event was much more severe. Over the whole of October, rainfall was highest of any October on record at Galway Airport and Maam Valley.

Note: the reported depth of 67.3mm at gauge 2521 on 30 October was probably in fact an accumulation over four days, as zero rainfall was reported at this gauge for the preceding three days.

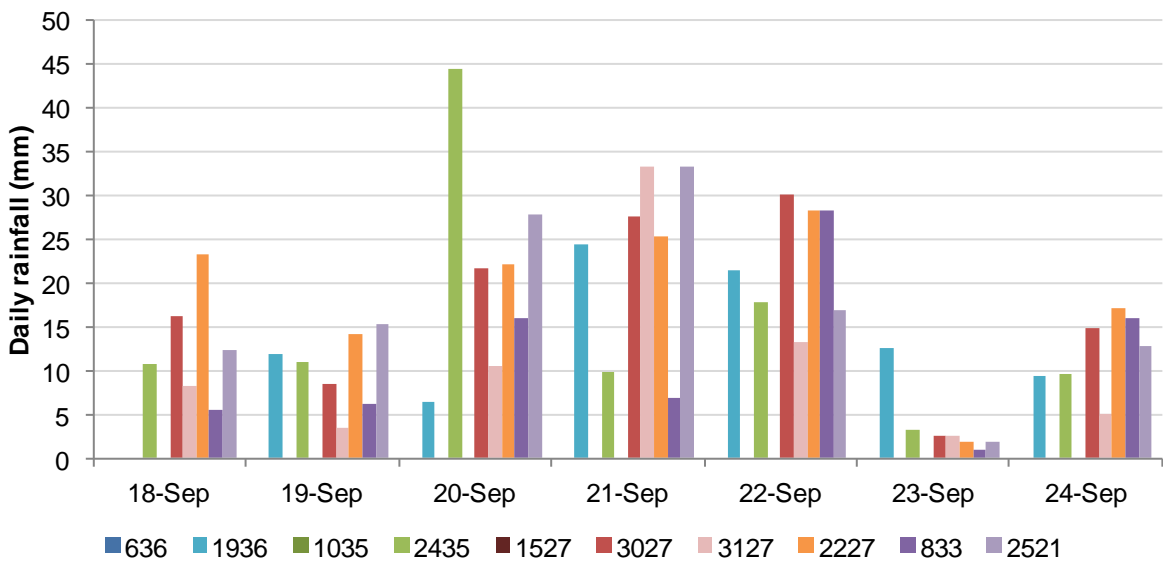
Rainfall event summary sheet

17 to 23 September 2006



Depth duration frequency at selected gauges with the most extreme rainfalls

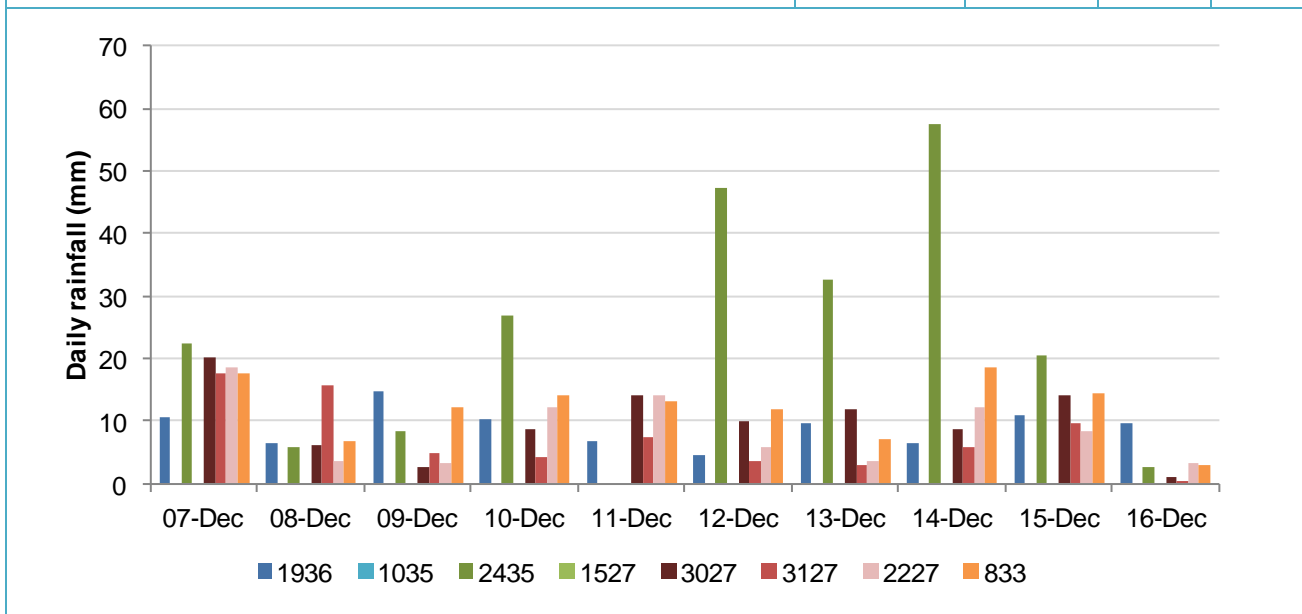
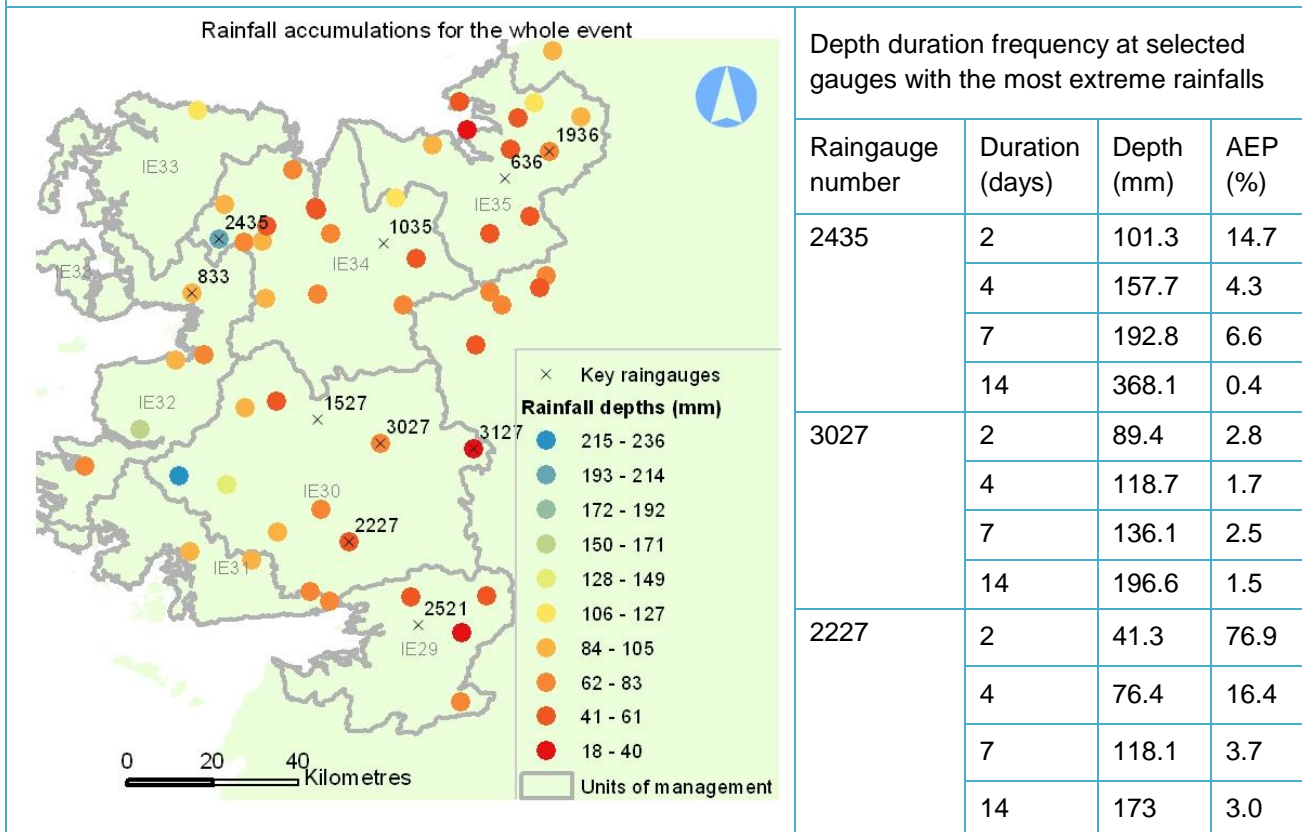
| Raingauge number | Duration (days) | Depth (mm) | AEP (%) |
|------------------|-----------------|------------|---------|
| 3027 | 1 | 30.2 | 76.9 |
| | 2 | 57.9 | 23.3 |
| | 4 | 88.1 | 9.6 |
| | 7 | 121.7 | 5.2 |
| 2227 | 1 | 28.4 | 90.9 |
| | 2 | 53.8 | 27.8 |
| | 4 | 90.1 | 4.6 |
| | 7 | 132.4 | 1.3 |
| 2521 | 1 | 33.4 | 76.9 |
| | 2 | 61.3 | 13.7 |
| | 4 | 93.6 | 4.0 |
| | 7 | 120.7 | 3.5 |



This was the warmest September on record in many parts of Ireland. Deep Atlantic depressions brought wet and windy weather. The rain on 20th-21st was caused by the remnants of Hurricane Gordon. This event was more severe in the south of the RBD, with multi-day accumulations having AEPs around 5% in hydrometric areas 29 and 30. The lowest AEP was at gauge 2227, Carndolla, between Galway and Headford, where the maximum 7-day accumulation had an AEP of 1.3% (a return period of 70 years).

Rainfall event summary sheet

9 to 15 December 2006



A series of very deep depressions passing to the northwest of Ireland brought rain, accompanied by strong south-westerly winds. There was rain almost every day from 7 November to mid-December. During 9-15 Dec there were exceptionally high totals in the western mountainous areas, particularly at gauge 2435 (Keenagh Beg, in the Nephin Beg hills above Crossmolina) where the AEP over 2 weeks was 0.4%, i.e. a return period of 400 years. The event was also notable in hydrometric area 30, with AEPs of 1-3% at gauges 3027 and 2227. It is possible that some of the low rainfall totals shown on the map are due to missing data.

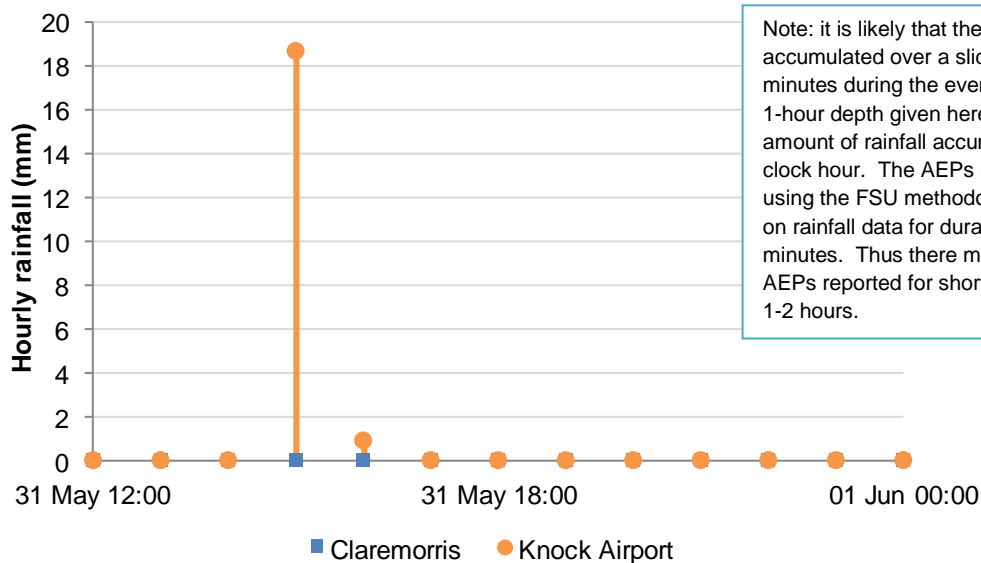
Appendix C – Rainfall analysis

Sub-daily rainfall event summary sheet

31 May 2008

Hourly rainfall data is available from two gauges in the study area, Claremorris and Knock Airport.

| Depth duration frequency at Claremorris | | | Depth duration frequency at Knock Airport | | |
|---|------------|---------|---|------------|---------|
| Duration (hours) | Depth (mm) | AEP (%) | Duration (hours) | Depth (mm) | AEP (%) |
| 1 | 0.1 | n/a | 1 | 18.7 | 15.0 |
| 2 | 0.1 | n/a | 2 | 19.6 | 27.7 |
| 3 | 0.1 | n/a | 3 | 19.6 | 41.2 |
| 4 | 0.1 | n/a | 4 | 19.6 | High |
| 6 | 0.1 | n/a | 6 | 19.6 | High |
| 9 | 0.1 | n/a | 9 | 19.6 | High |
| 12 | 0.1 | n/a | 12 | 19.6 | High |



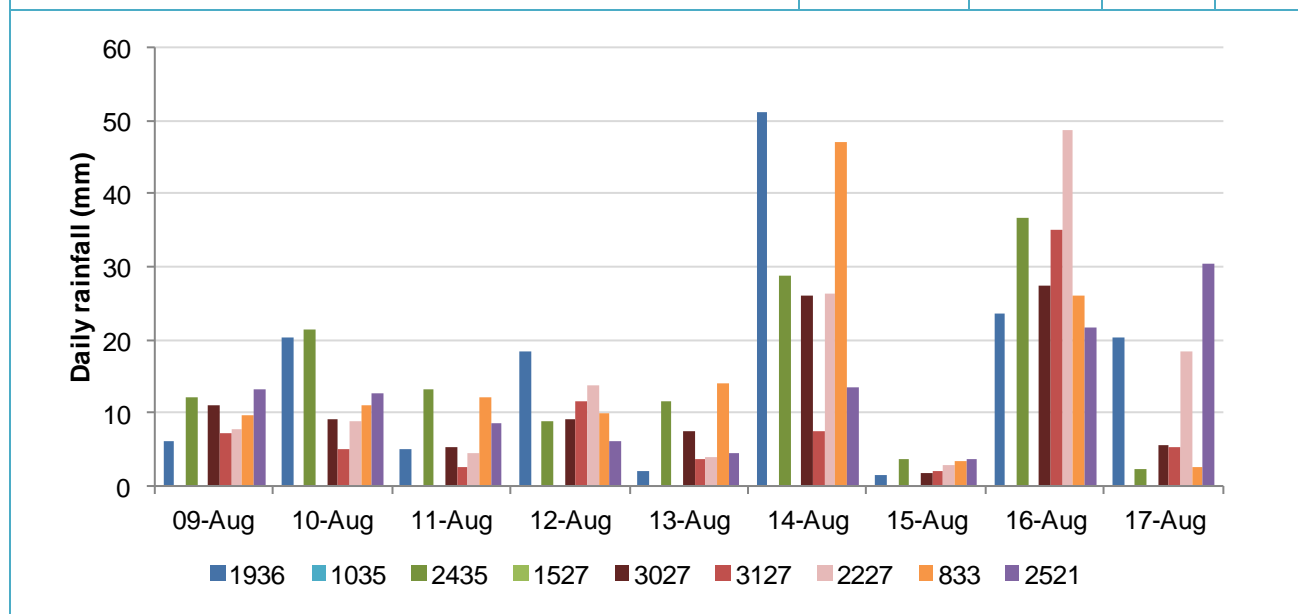
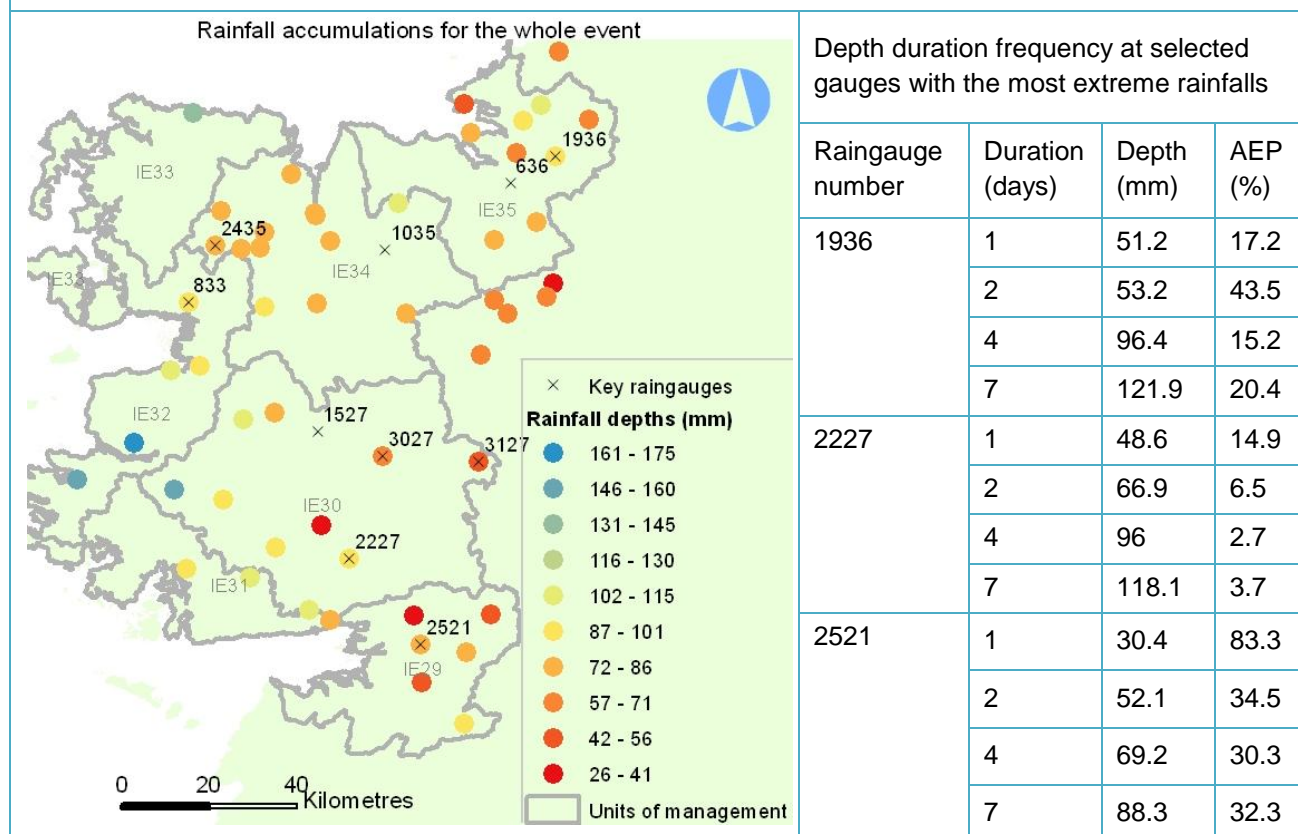
Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.

May 2008 was sunny, dry and warm. On 31st, a very warm day, a thunderstorm in County Mayo resulted in a brief intense fall of rain which was recorded at Knock Airport. 25km to the south-west at Claremorris there was no rain. From the daily rainfall data it appears that the highest rainfall was 25mm at Strade, north-east of Castlebar.

The 1-hour fall of 18.7mm is the highest on record to date at Knock Airport (1996-2010) and had an AEP of 15% (i.e. a return period of 7 years).

Rainfall event summary sheet

14 to 16 August 2008



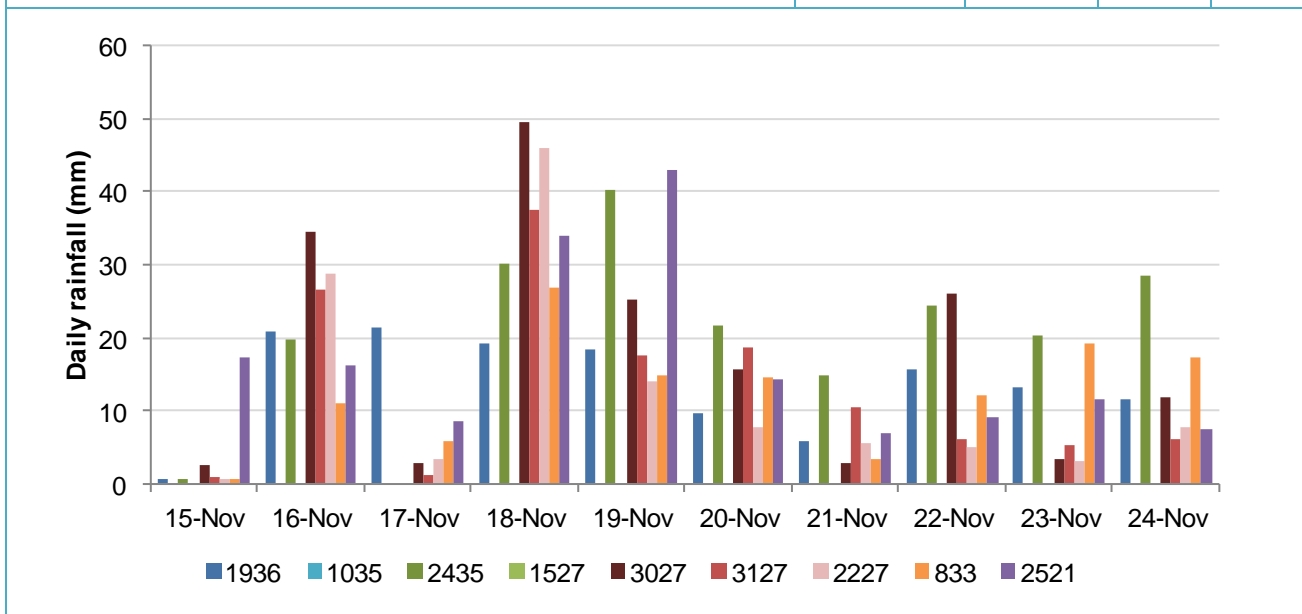
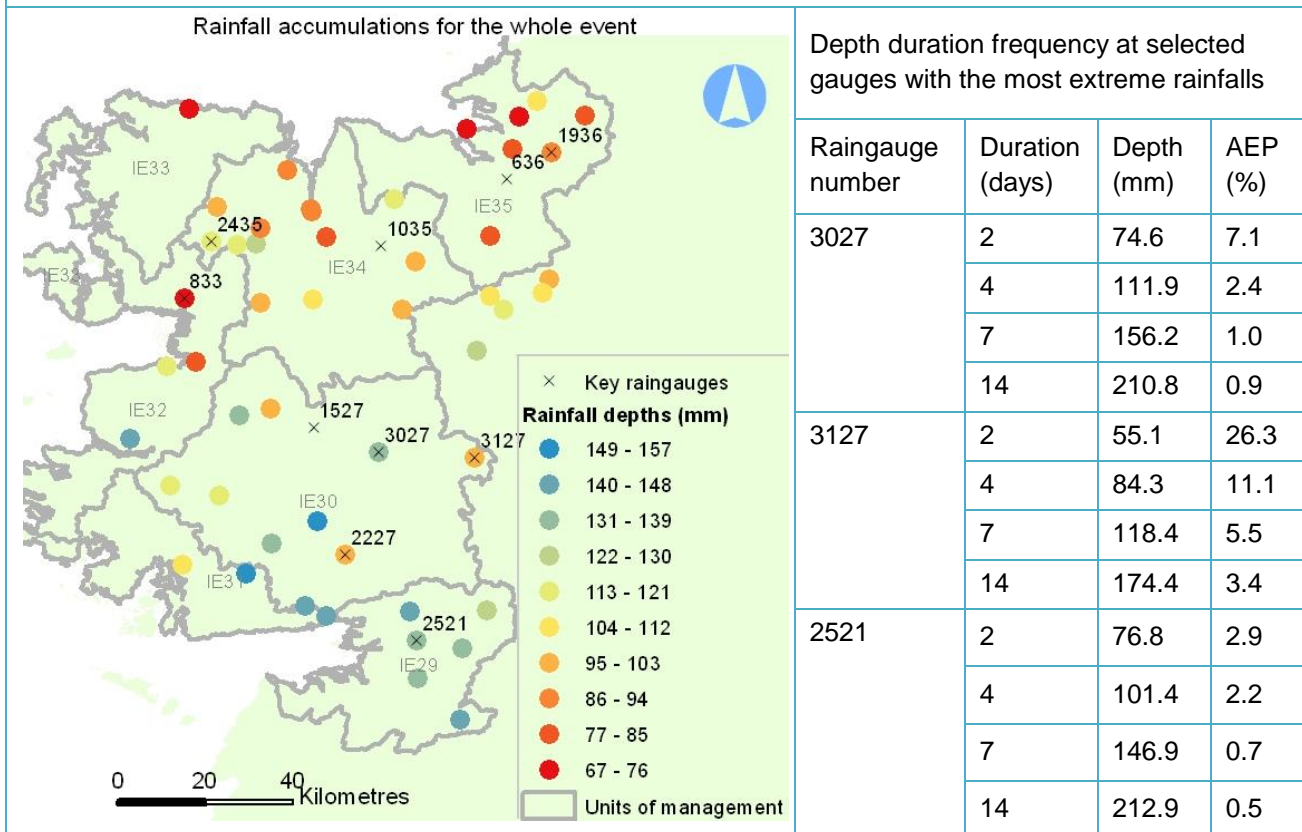
Low pressure close to or over Ireland brought a succession of Atlantic frontal systems across the country, giving some significant falls on 14th and 16th. It was the wettest August in some parts of Ireland. The event affected all of the Western RBD. It was not particularly severe, with an AEP exceeding 30% at most gauges. The lowest AEP was 3% for the 4-day total at gauge 2227, Carndolla.

Further information on this event is available in Met Éireann's Climatological Note No. 11.

Note: some of the low rainfalls shown on the map are due to periods of missing data.

Rainfall event summary sheet

15 to 20 November 2009



Atlantic depressions passing close to Ireland brought wet and windy conditions throughout almost all of November, continuing a pattern of very unsettled weather over Ireland that began in mid-October. Rainfall totals for November were the highest on record at most stations. In the Western RBD rain fell almost every day from 18 October to 28 November. The highest totals were in the south of the RBD, in hydrometric areas 29 to 31, particularly in the vicinity of Galway. The AEP was below 1% (a return period of 150-200 years) for 1 and 2-week accumulations at gauge 2521, Craughwell, south of Athenry.

Further information on this event is available in Met Éireann's Climatological Note No. 12.

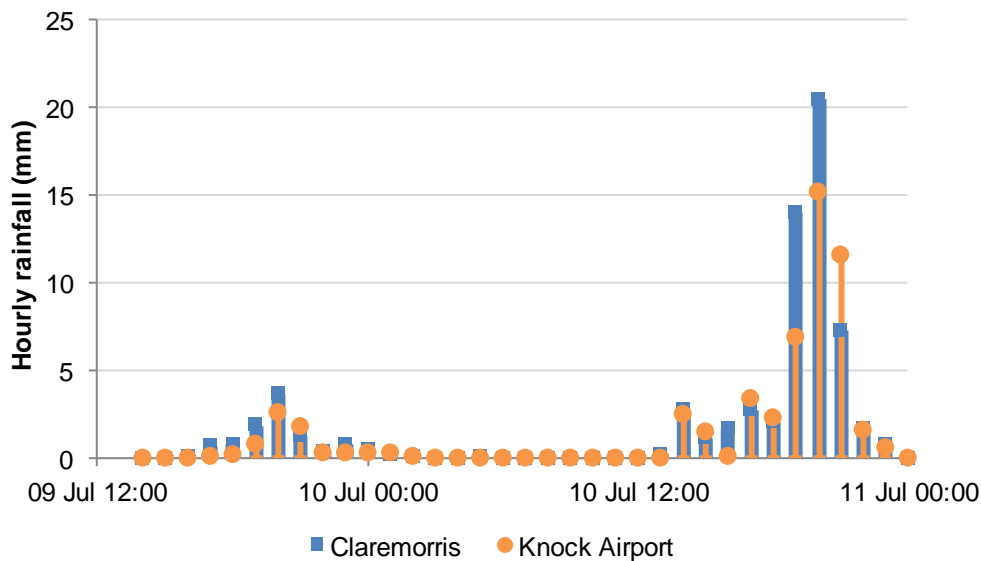
Sub-daily rainfall event summary sheet

10 July 2010

Hourly rainfall data is available from two gauges in the study area, Claremorris and Knock Airport.

| Depth duration frequency at Claremorris | | | Depth duration frequency at Knock Airport | | |
|---|------------|---------|---|------------|---------|
| Duration (hours) | Depth (mm) | AEP (%) | Duration (hours) | Depth (mm) | AEP (%) |
| 1 | 20.5 | 8.9 | 1 | 15.2 | 28.1 |
| 2 | 34.5 | 2.9 | 2 | 26.8 | 9.7 |
| 3 | 41.8 | 2.2 | 3 | 33.7 | 6.9 |
| 4 | 43.9 | 2.6 | 4 | 36 | 7.8 |
| 6 | 48.4 | 3.1 | 6 | 41 | 8.0 |
| 9 | 54.1 | 3.3 | 9 | 45.1 | 9.5 |
| 12 | 55.1 | 4.7 | 12 | 45.7 | 13.4 |

Note: it is likely that the maximum rainfall accumulated over a sliding duration of 60 minutes during the event was higher than the 1-hour depth given here which refers to the amount of rainfall accumulated within each clock hour. The AEPs here are calculated using the FSU methodology which was based on rainfall data for durations as short as 15 minutes. Thus there may be a bias in the AEPs reported for short durations, particularly 1-2 hours.



Rain fell across Ireland most days of July 2010, associated with frontal systems moving eastwards over Ireland, as unusually deep depressions for July tracked close to the west coast. On 10 July maximum temperatures were 16-20°C and winds became stronger through the day. A band of persistent rain in the south of the country during the morning spread northwards to affect all areas by afternoon. Further heavy thundery pulses moved up from the south during the afternoon and evening, producing extremely heavy falls in the west. The rain cleared from the southwest by evening.

The highest rainfall in the country during this event was recorded at Claremorris. At both Claremorris and Knock Airport rain was particularly heavy from 6-9pm. Over a 3-hour duration the AEP was 2.2% at Claremorris (a return period of 50 years) and 7% at Knock Airport.

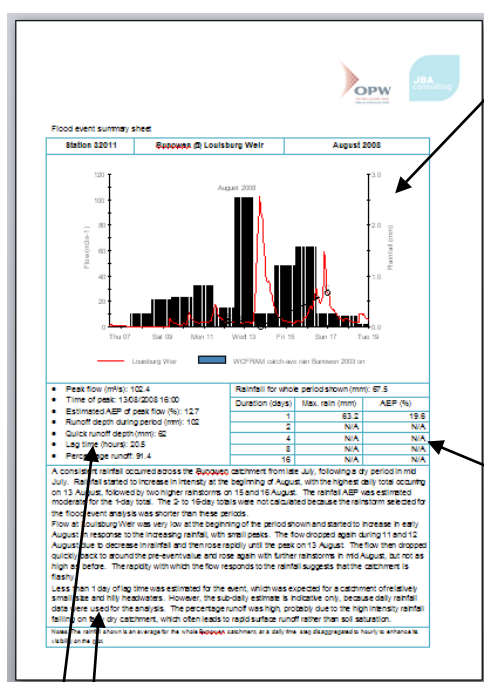
Introduction to Flood event summary sheets

This appendix provides a description and analysis of previous flood events which have been recorded at gauging stations within the unit of management.

Selection of events

At most gauges around three events have been selected for analysis. In general these are the events with the top-ranking peak flows for which continuous flow data are available. In a few cases analysis has been carried out at river level gauges for which no rating equation currently exists, and so water level has been analysed in place of flow.

Information provided in the summary sheets



Graph of flow and rainfall

For large catchments, rain is shown as an average over the entire catchment (which may be larger than the area draining to the river gauge being analysed), calculated from daily rainfall data using Thiessen polygons to allocate weights for the averaging. Up to eight gauges are used. For smaller catchments, the rain data is from a single gauge chosen to be as representative as possible of the catchment.

The graph plots the rainfall at an hourly timestep, each hourly depth being 1/24 of the daily total.

Analysis of rainfall

Depths and annual exceedence probabilities (AEPs) of the highest 1-day, 2-day, 4-day... rainfalls recorded during the event. Where catchment-average rainfall is plotted, AEPs are calculated using catchment-mean parameters of the FSU rainfall depth-duration-frequency model. This is the approach recommended in Met Éireann Technical Note 61, as opposed to the alternative of calculating catchment-mean design rainfalls for numerous AEPs or the approach suggested by OPW of calculating the median design rainfall for the catchment. No areal reduction factor has been applied because the intention is to calculate the typical return period for point rainfalls within the catchment.

Results for longer durations are not always shown because calculations are carried out only for the period of rainfall selected for event analysis (see below)

Analysis of flood event

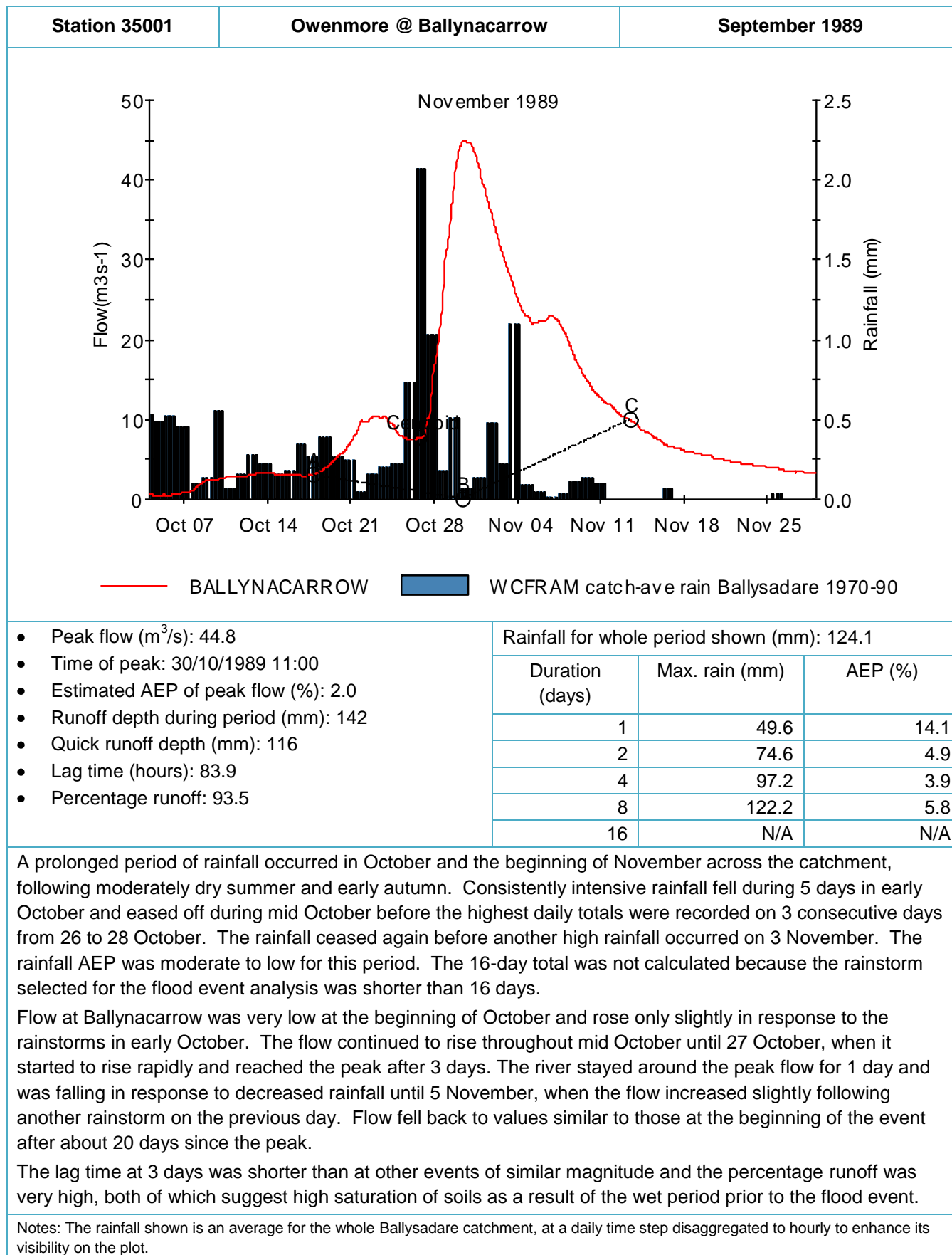
- Peak flow; date and time. Flows may not match the annual maximum values in the flood peak analysis sheets because the latter are generally extracted manually by the gauging authorities.
- Estimated annual exceedence probabilities (AEP) of peak flow, from the flood frequency curves shown in the flood peak analysis sheets. Not available where the flow record is very short.

Continued over the page...

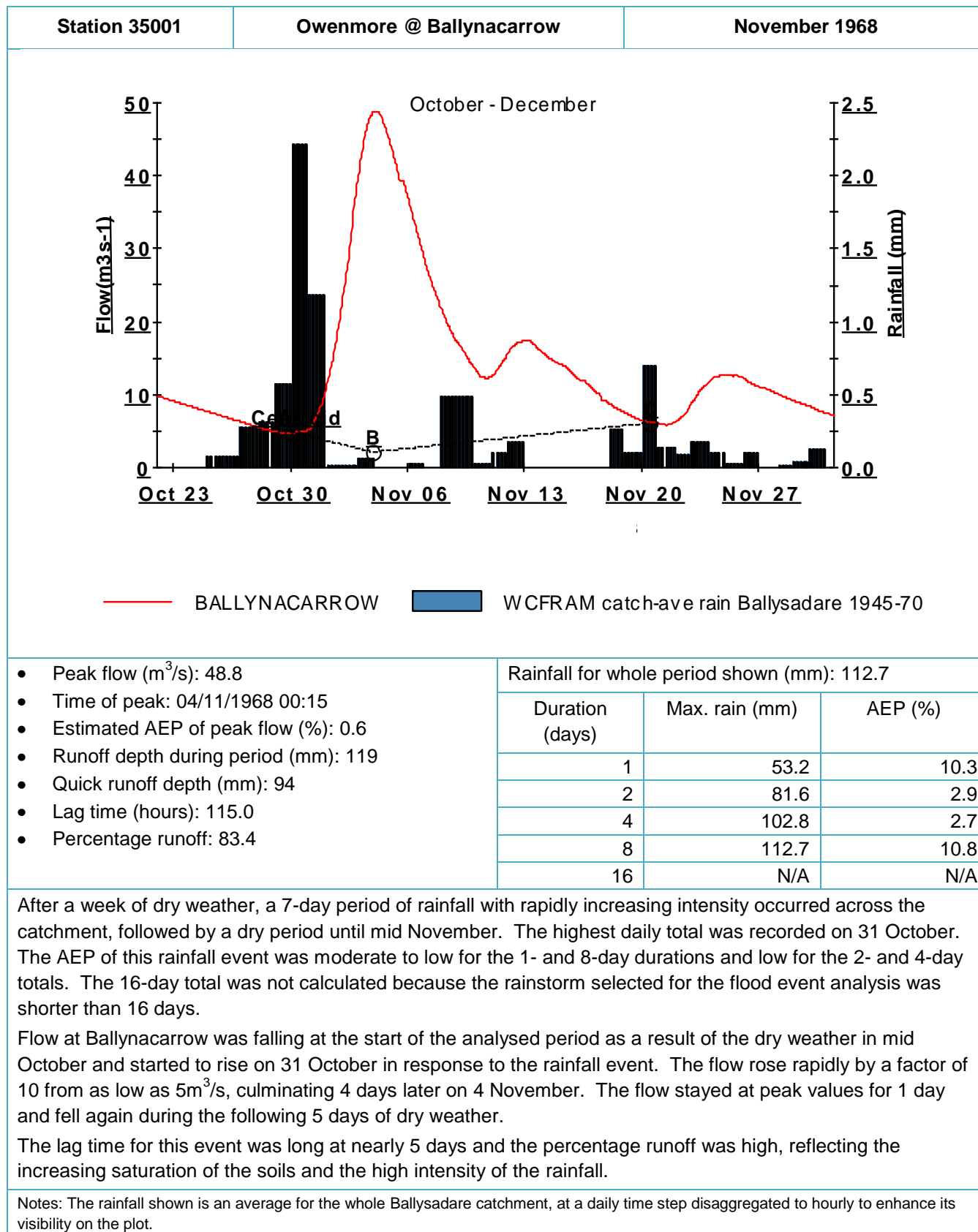
Continued...

- Depth of runoff during the period chosen for analysis. This is the volume of flow divided by the catchment area and expressed as an equivalent depth of water for comparison with the rainfall. The period chosen for analysis of flow has been chosen to represent the duration of the flood event. In most cases it is similar to or slightly shorter than the period shown on the graph. Many of the events consisted of sequences of rainfall periods resulting in multiple flood hydrographs.
- Depth of quick runoff, calculated by removing the baseflow using FSR methods for hydrograph separation. This can be regarded as the flow resulting from the storm rainfall.
- Lag time, calculated as the time between the centroid of the rainfall and the peak flow (or centroid of peaks for multi-peaked events). Because the rainfall data is daily, lag times below around 24 hours are highly approximate. Lag time was calculated using a period of rainfall chosen to exclude any rain falling after the peak of the flow. The period of rainfall chosen for analysis is that which is judged to have contributed to the flood hydrograph.
- Percentage runoff, i.e. quick runoff depth divided by rainfall depth. This is approximate in some cases, where rainfall has been averaged over an area greater than that draining to the gauge. As above, note that the analysis of rainfall is generally based on a different period of time to the analysis of flow. This helps to exclude rainfall which occurs towards the end of the flood hydrograph and thus does not contribute to runoff during the event being analysed.

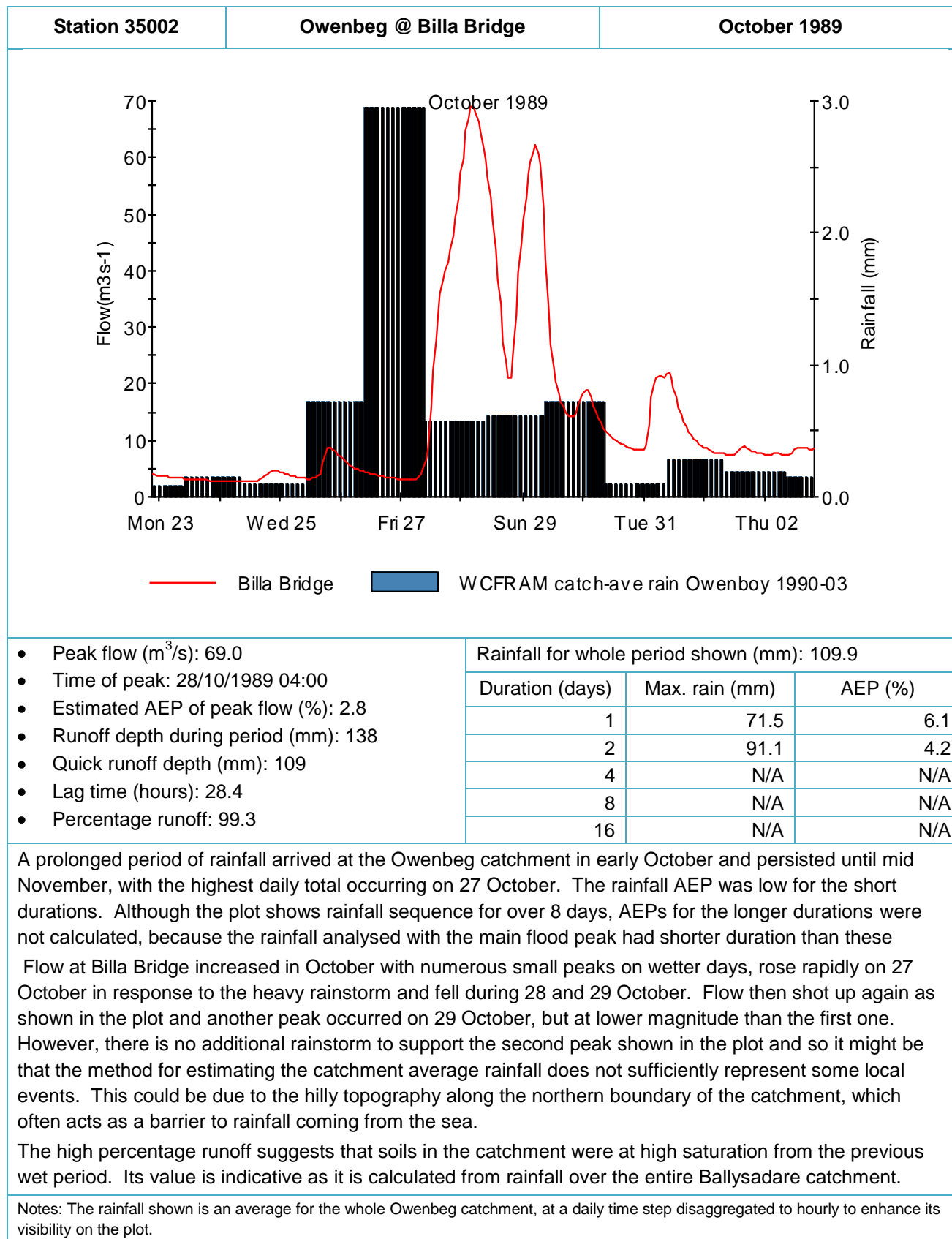
Flood event summary sheet



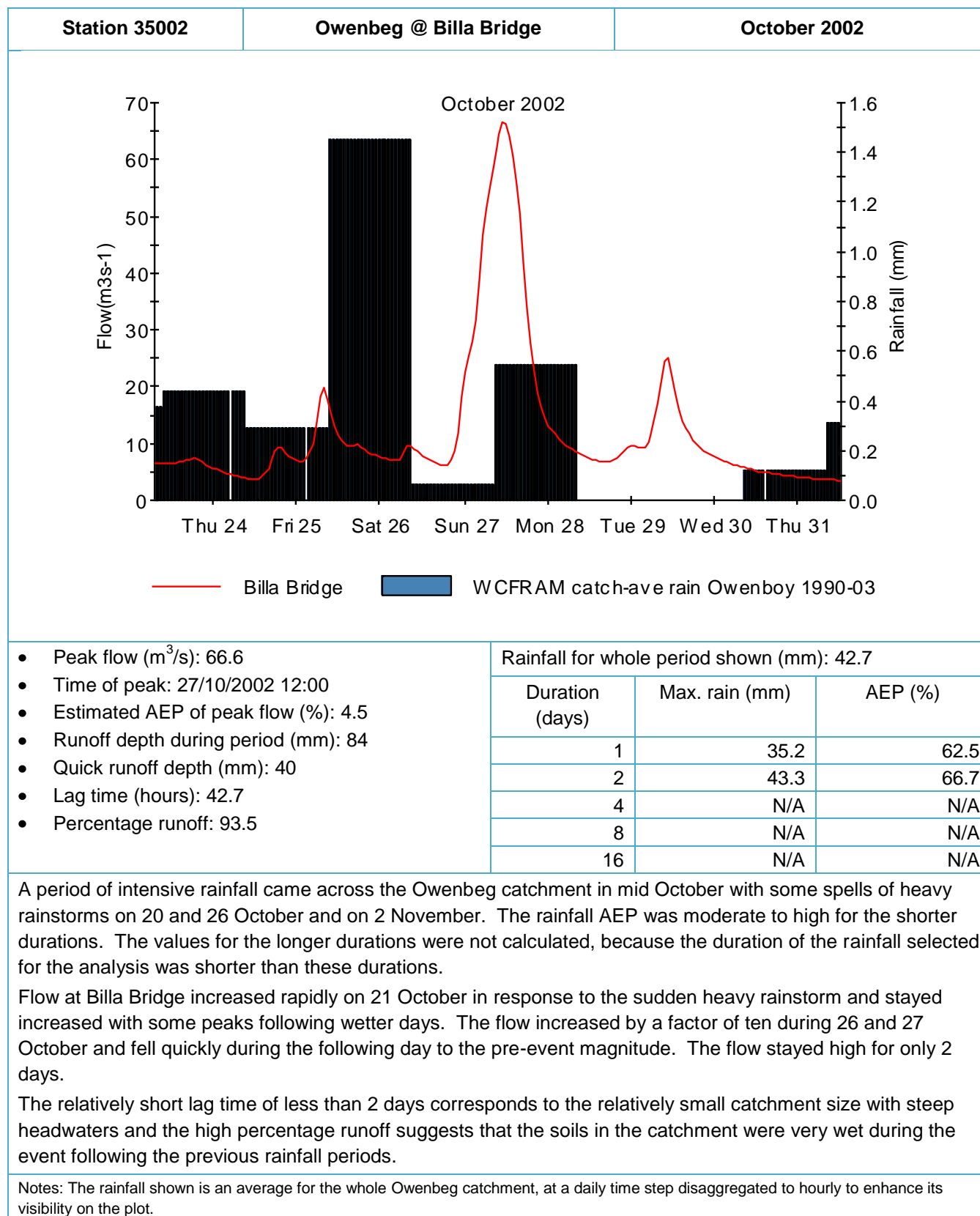
Flood event summary sheet



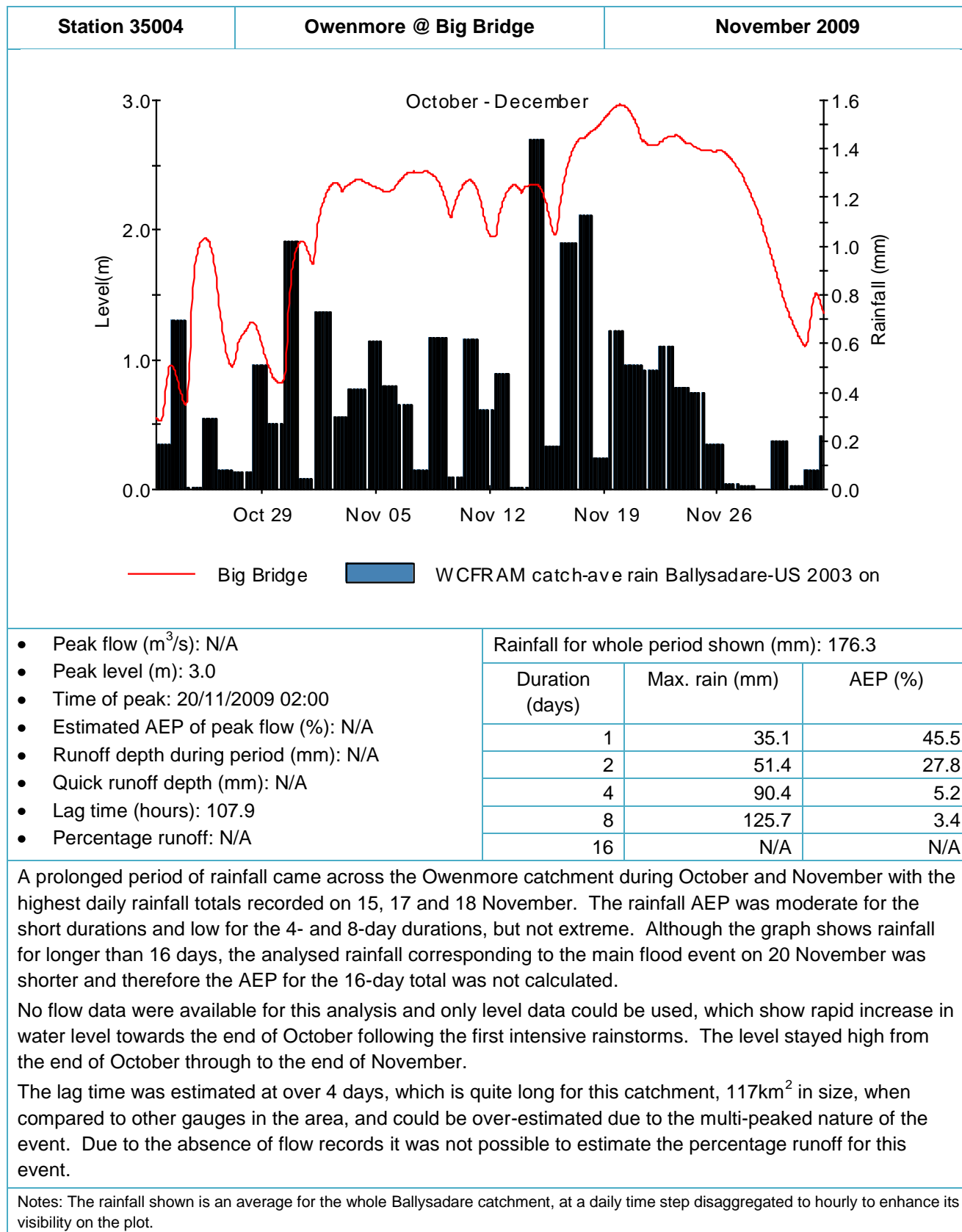
Flood event summary sheet



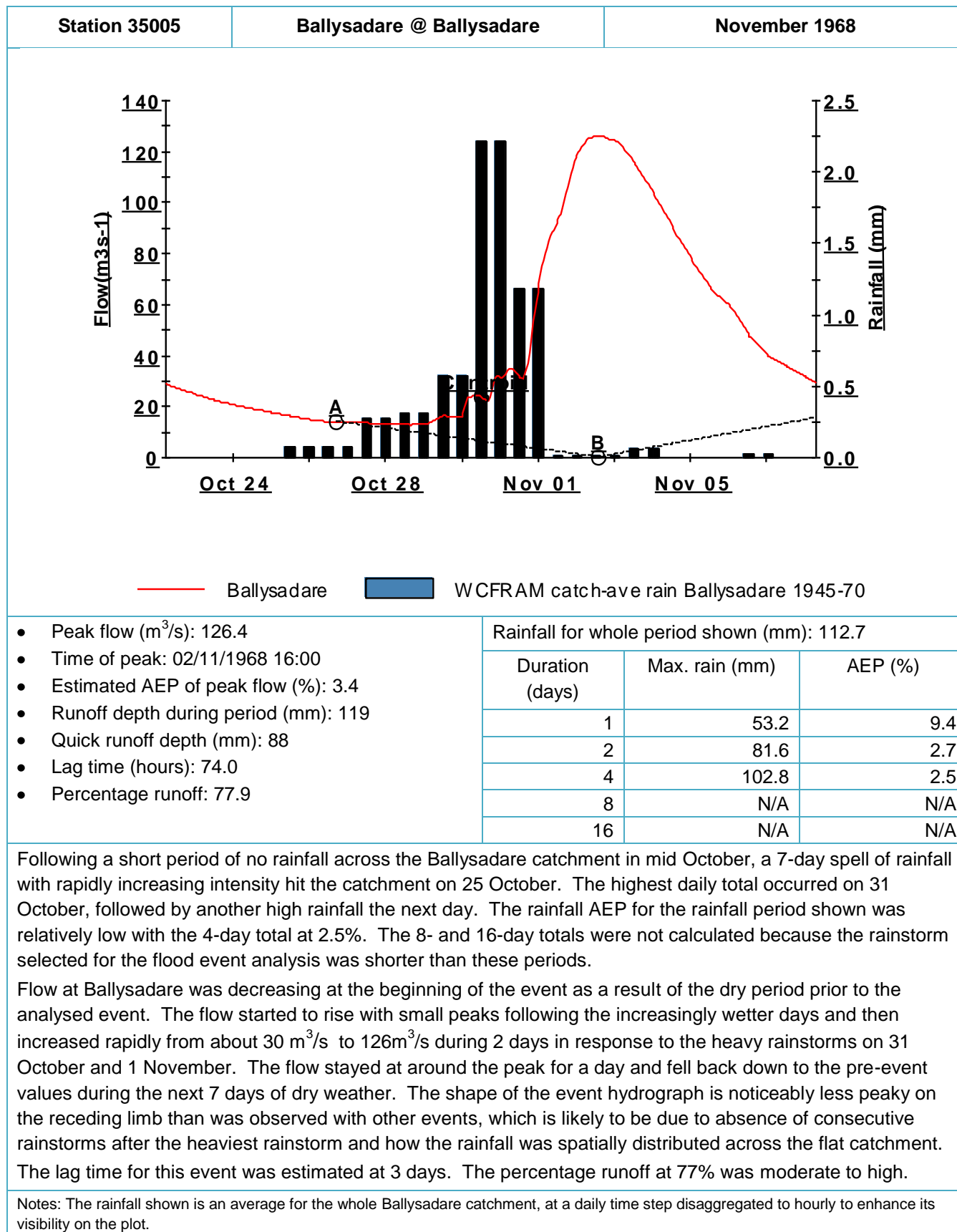
Flood event summary sheet



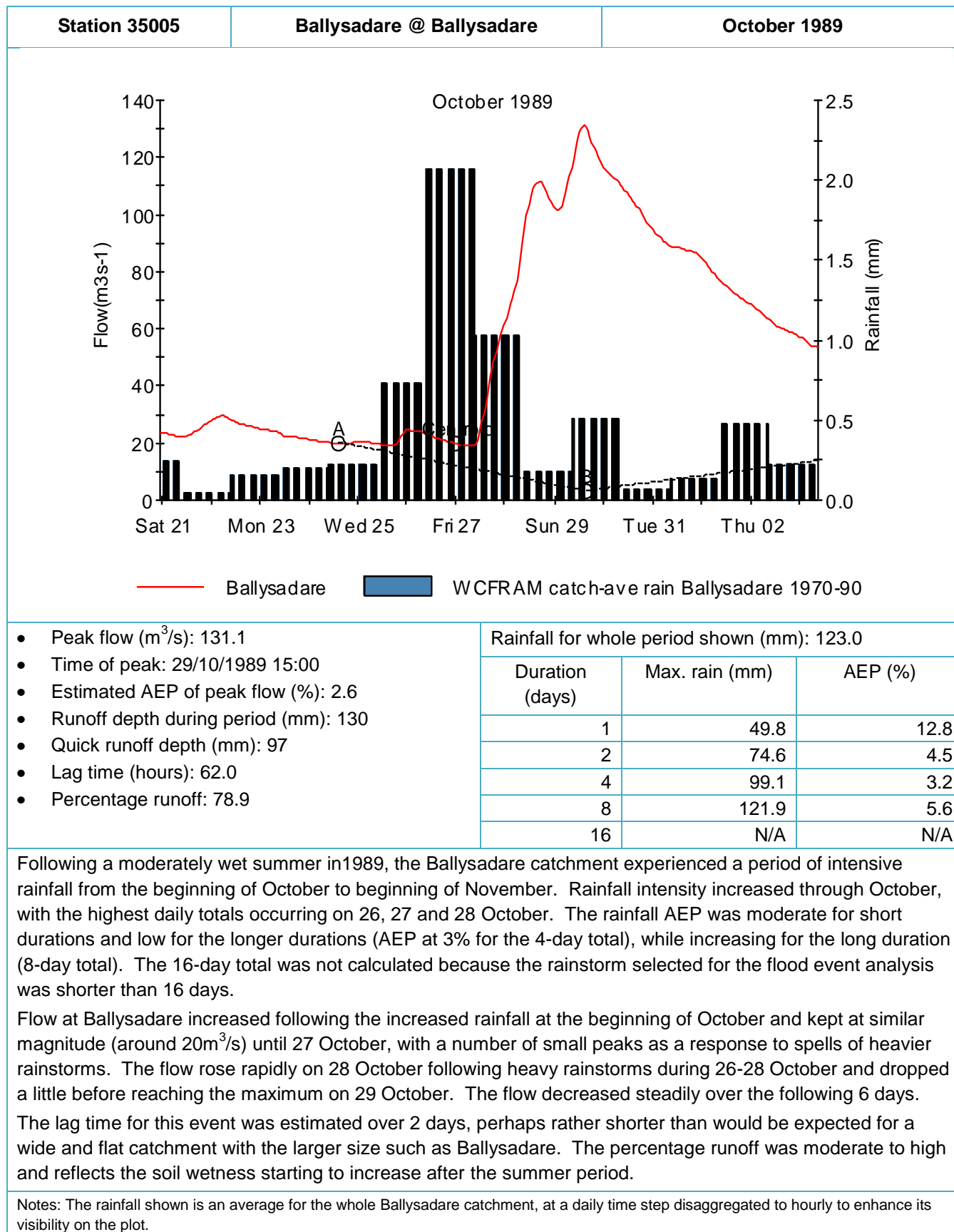
Flood event summary sheet



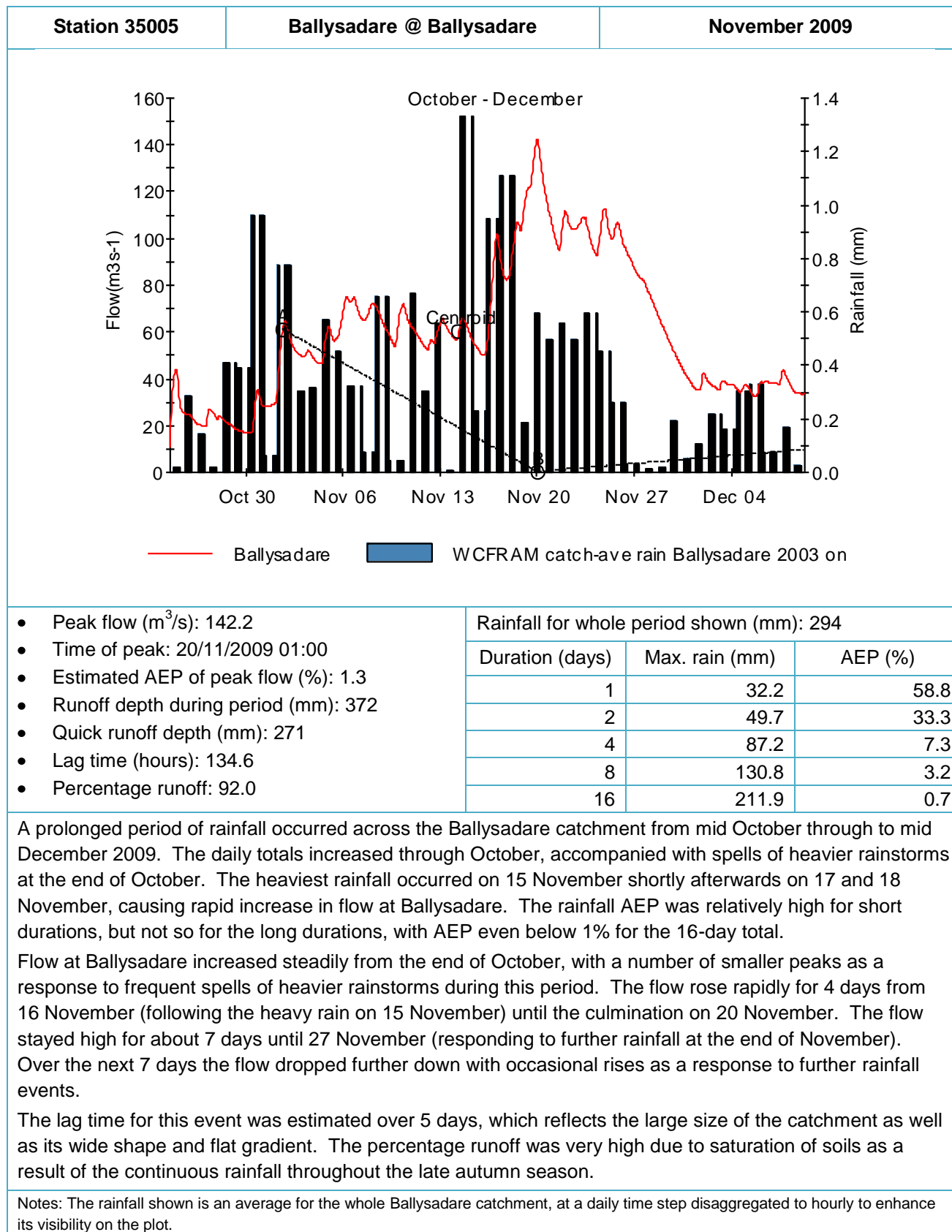
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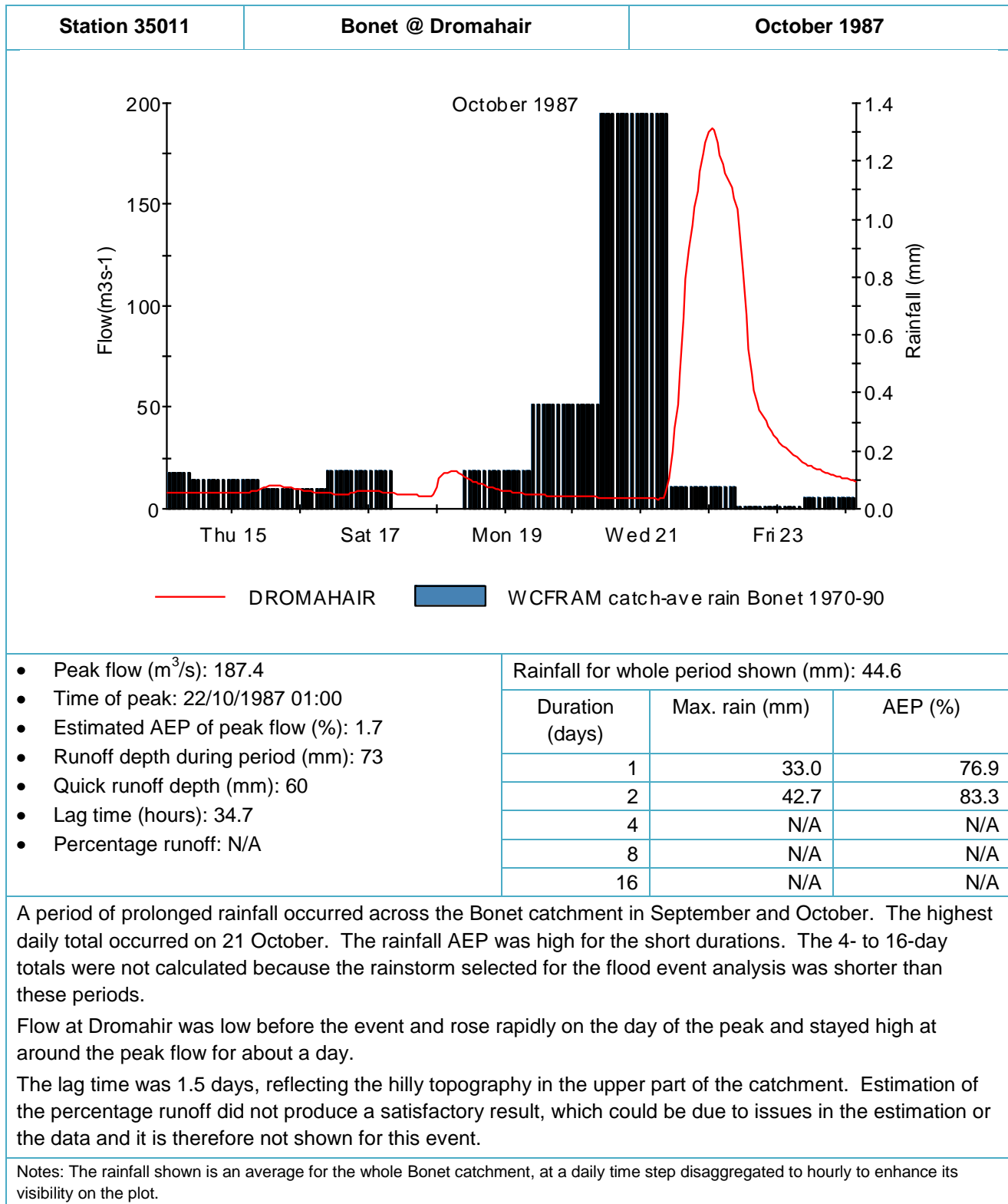
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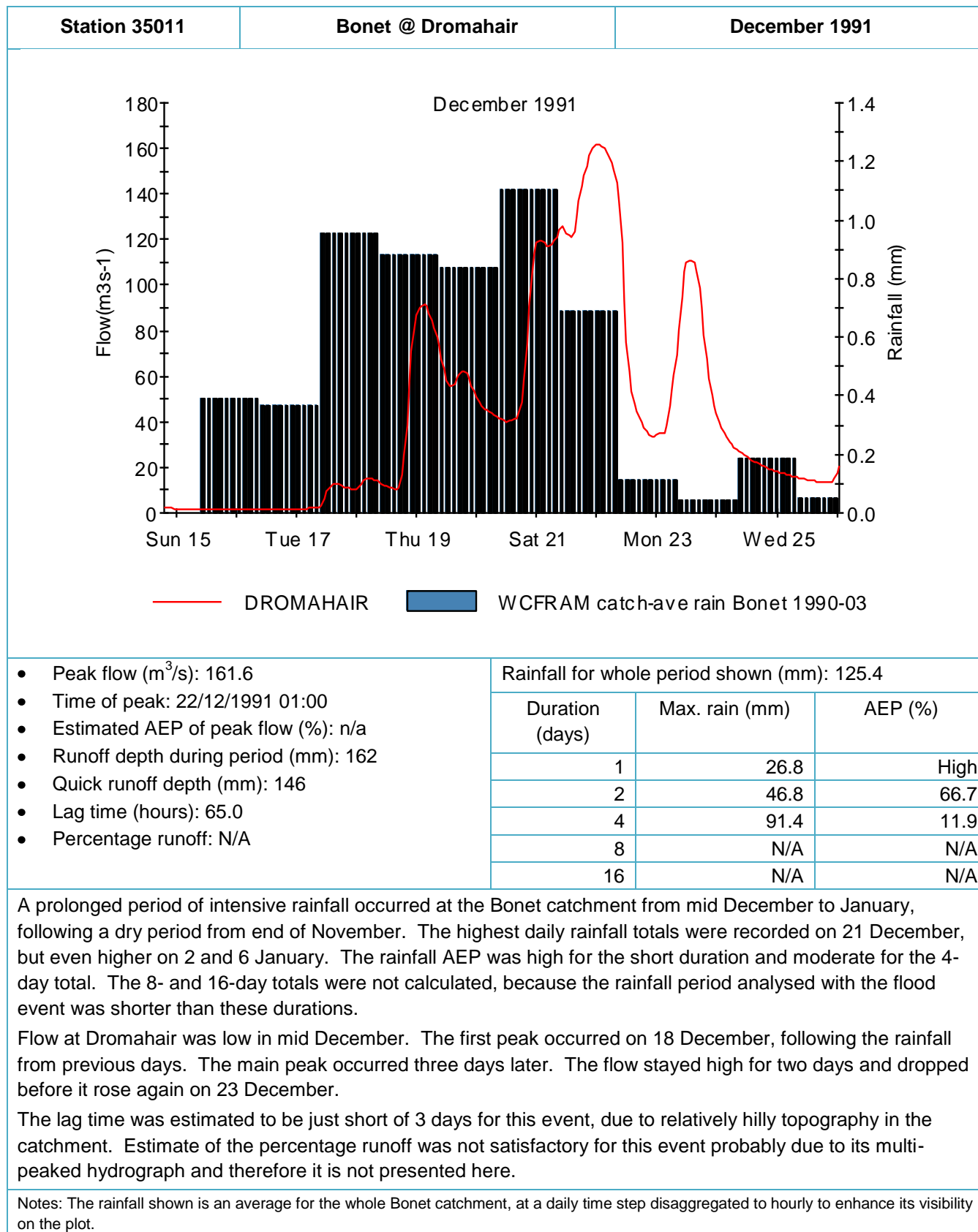
Flood event summary sheet



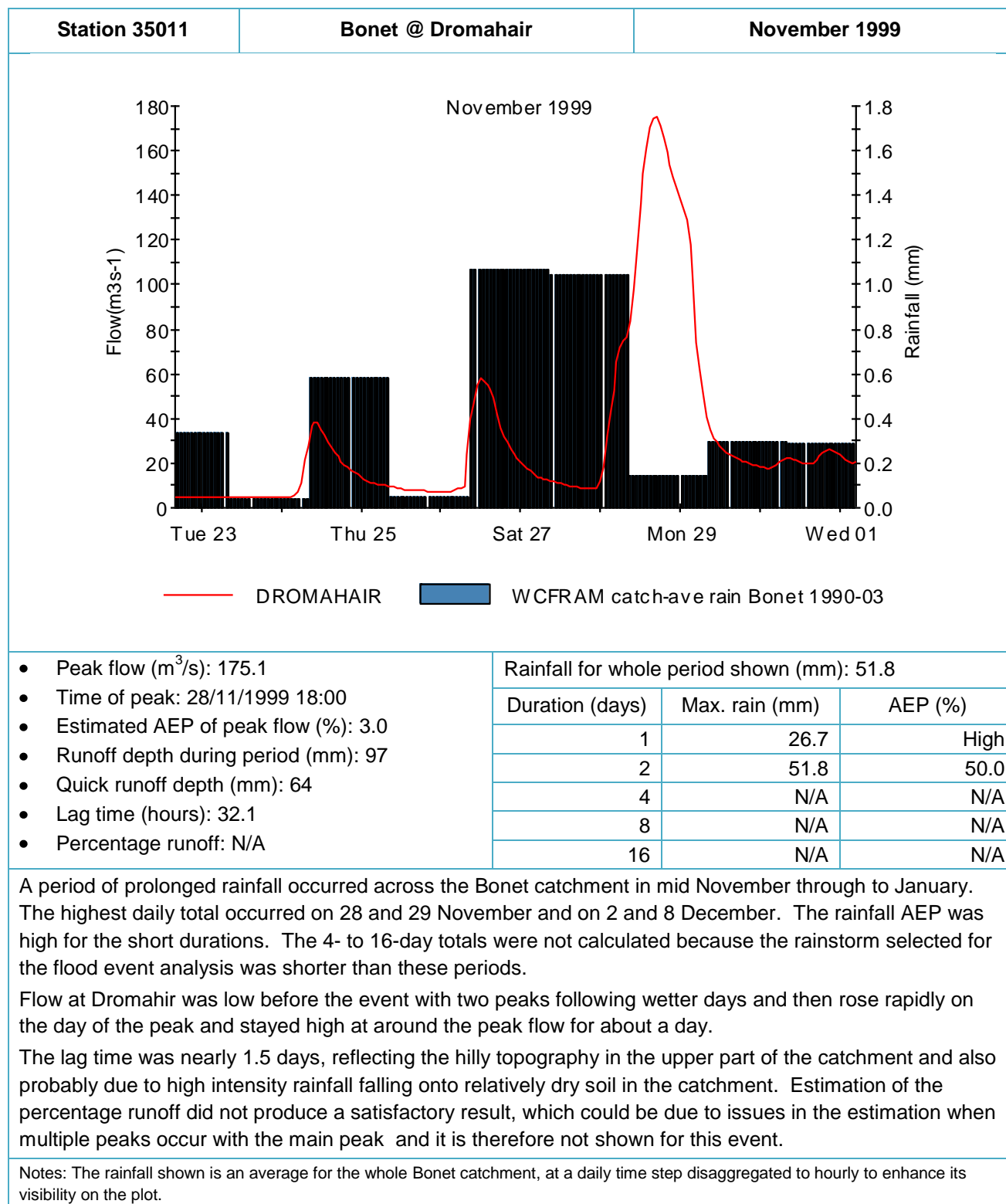
Flood event summary sheet



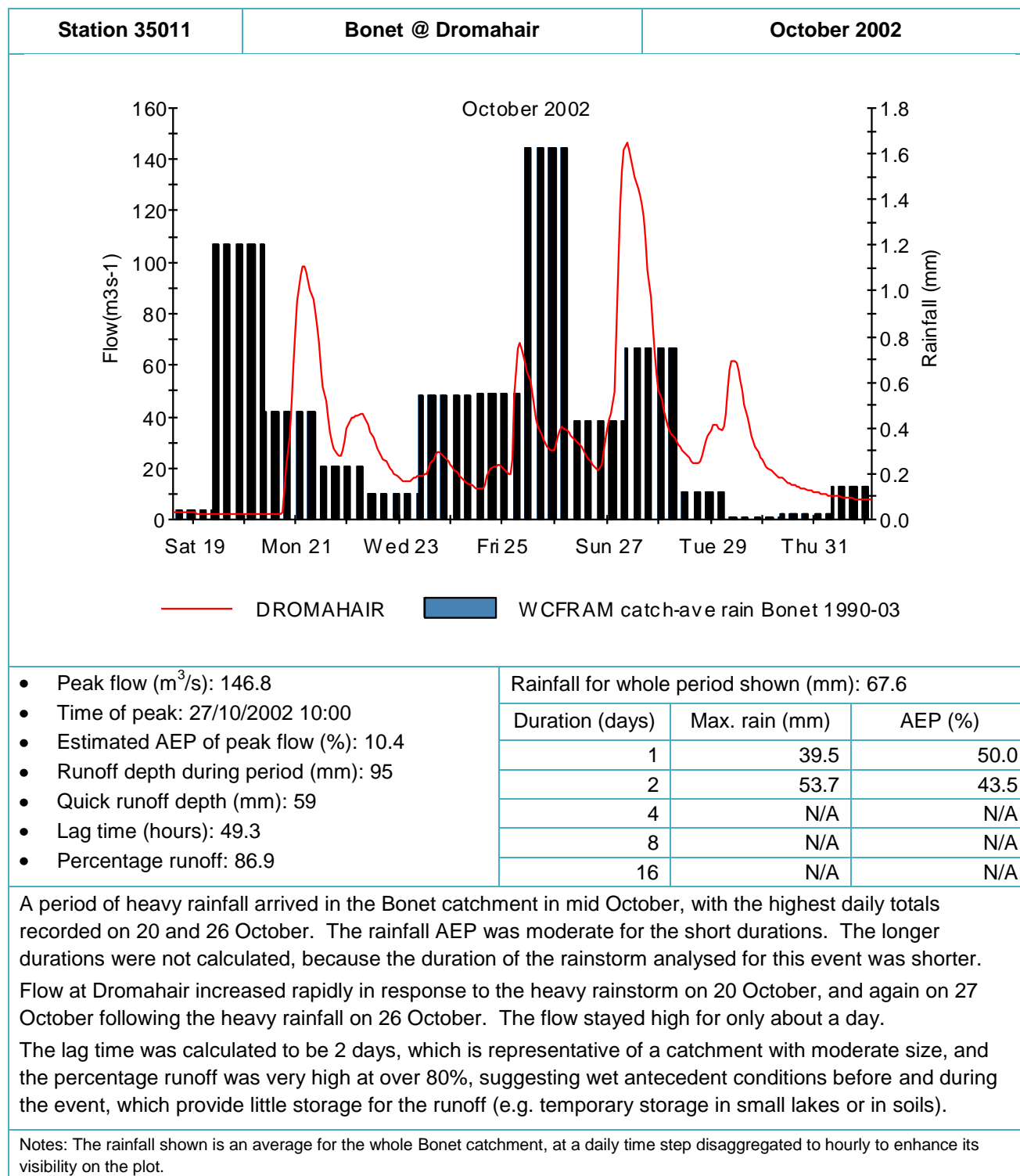
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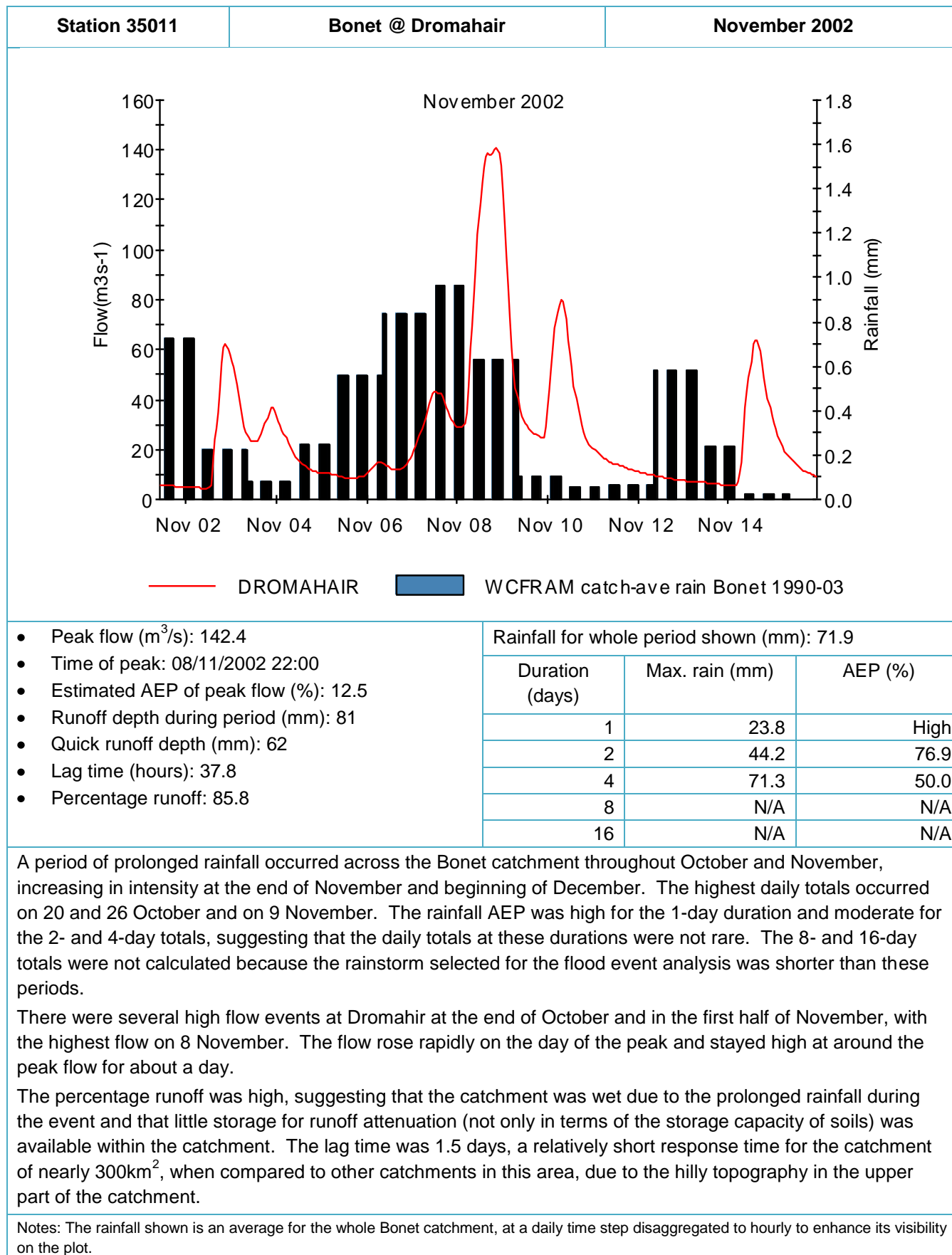
Flood event summary sheet



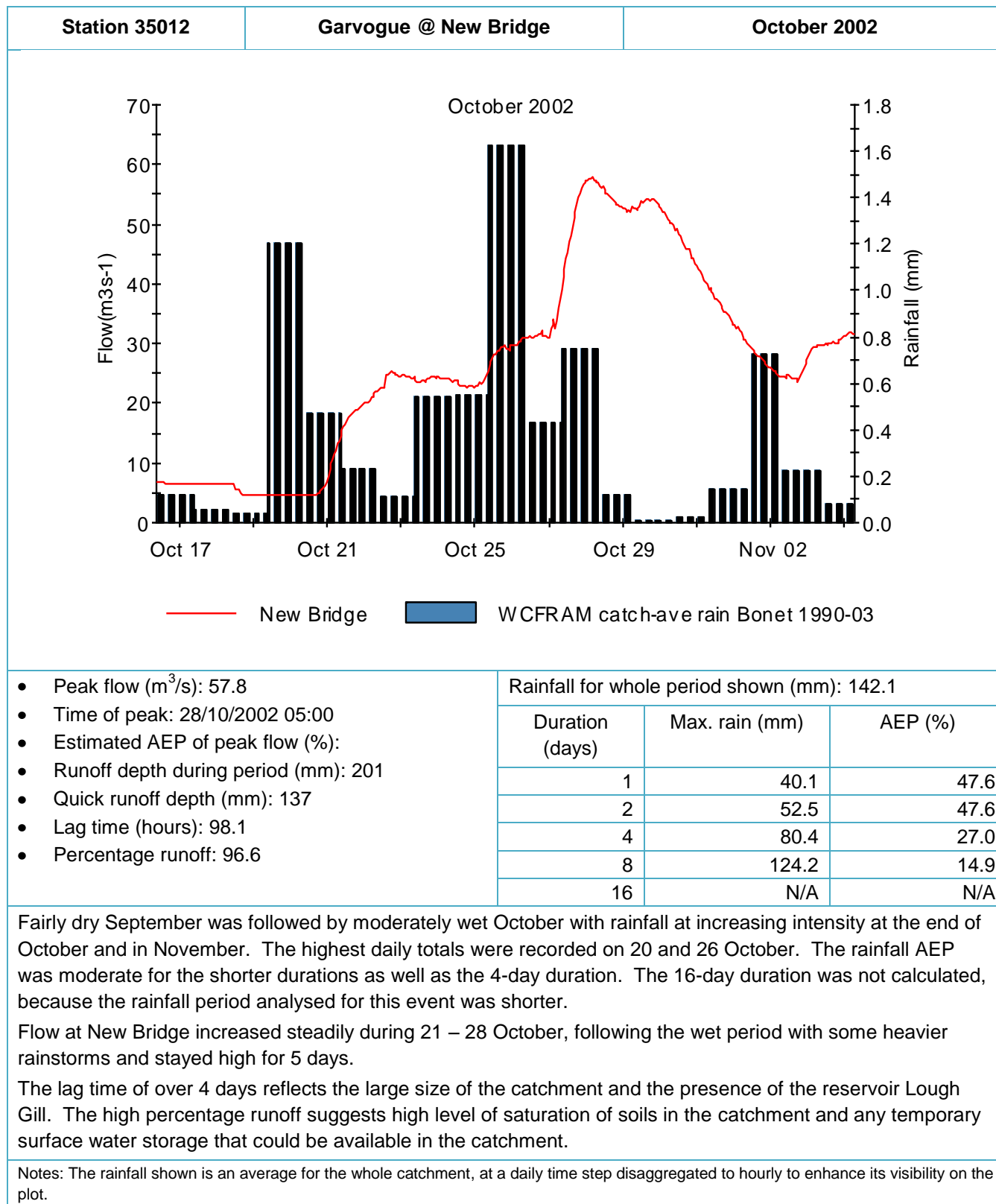
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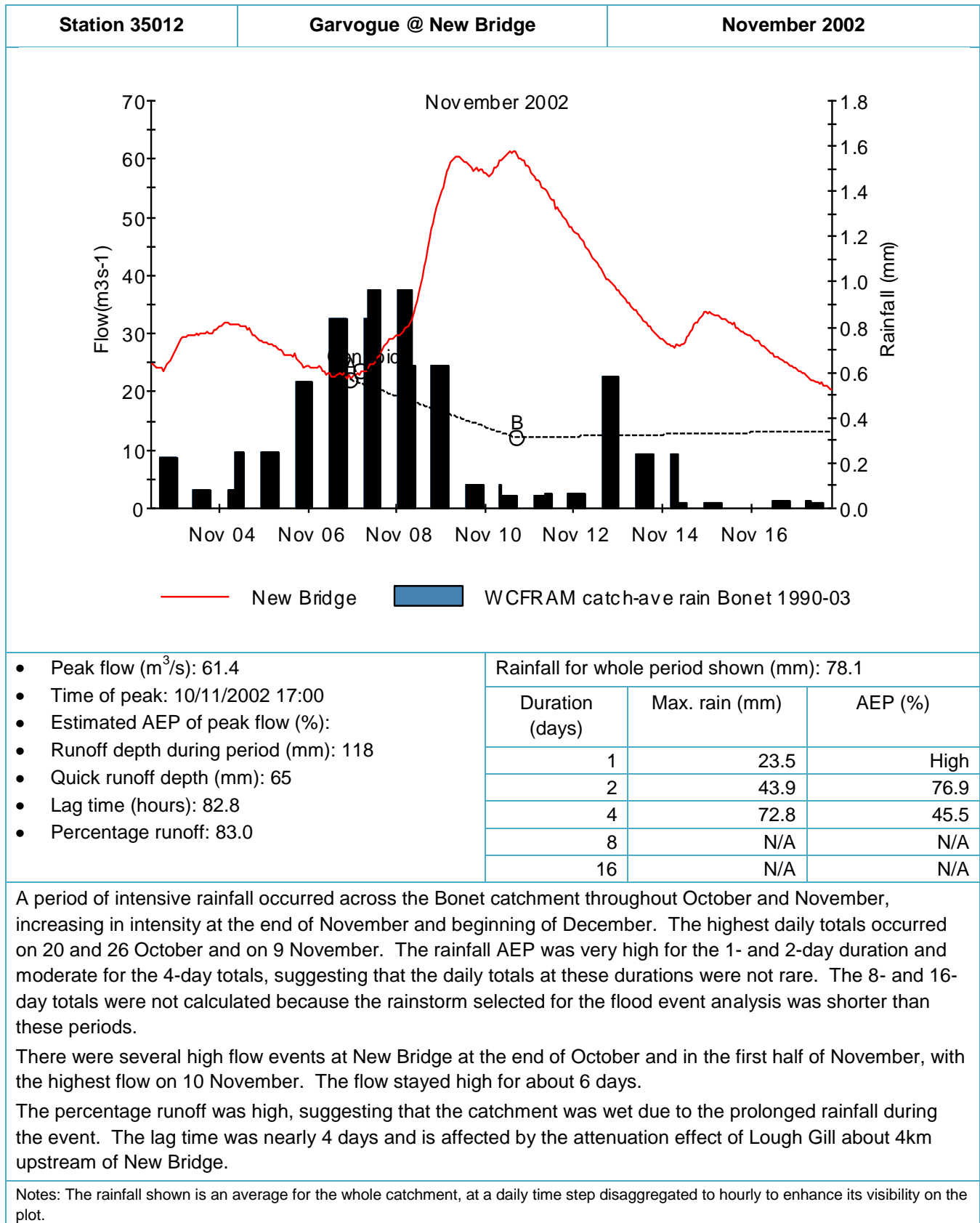
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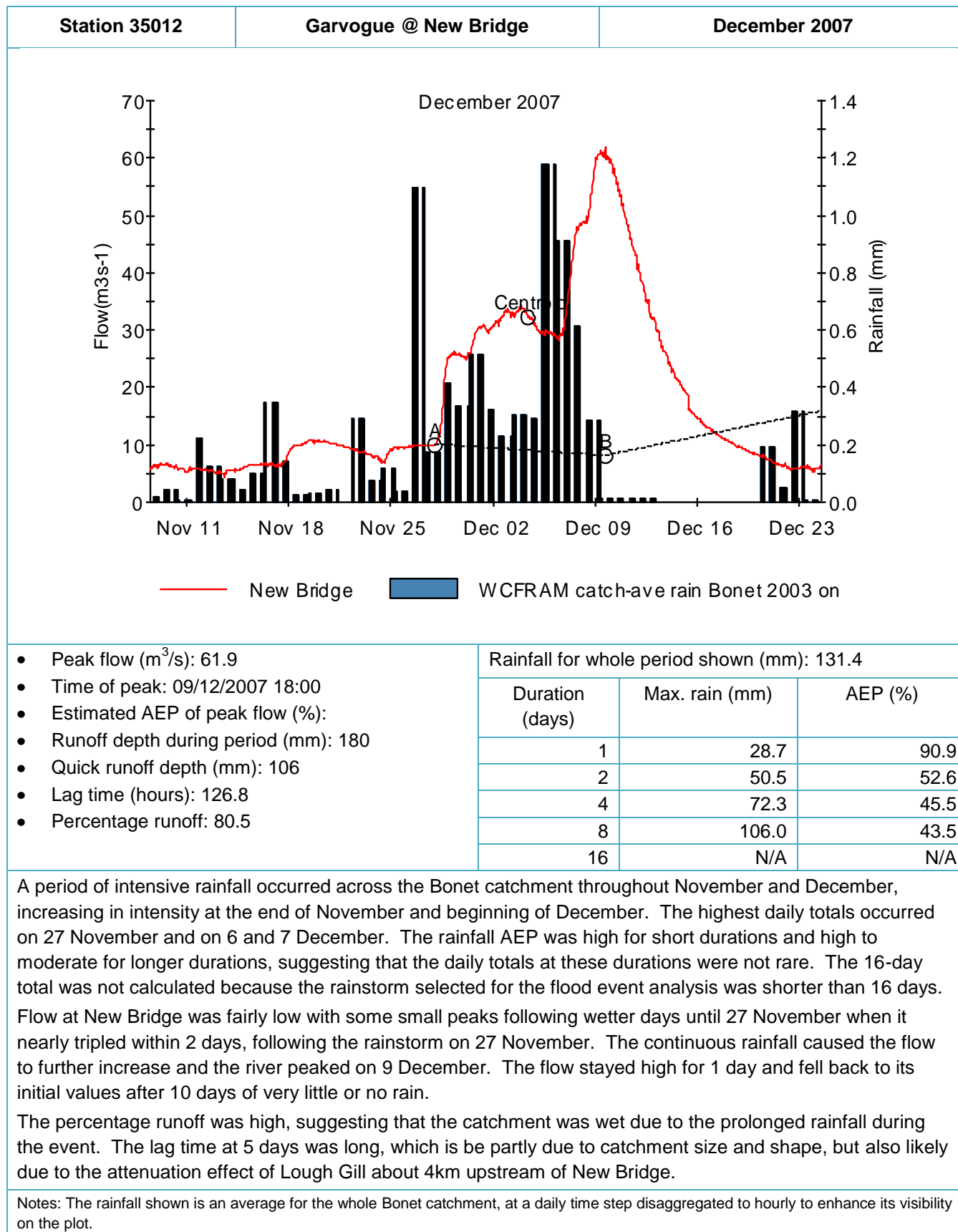
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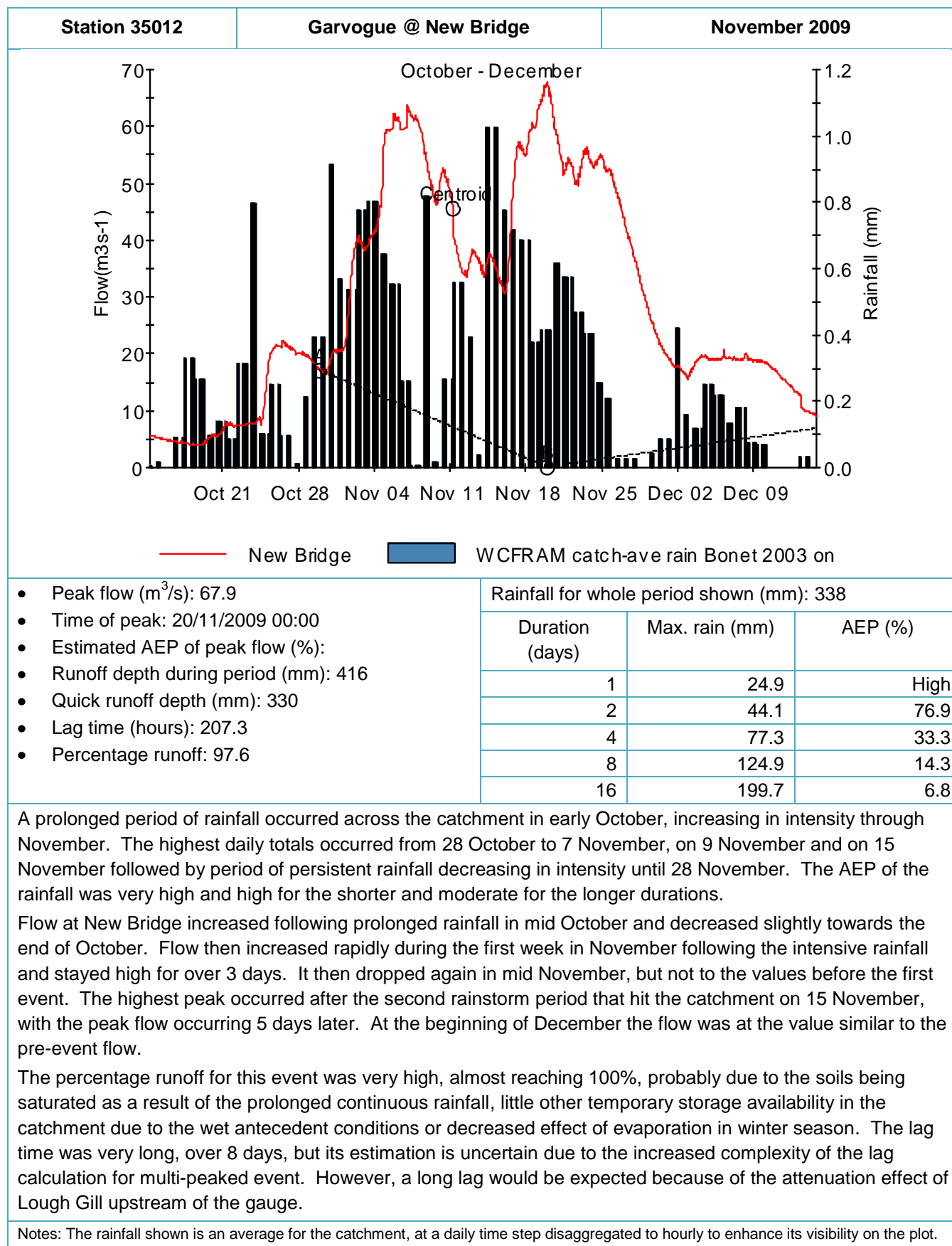
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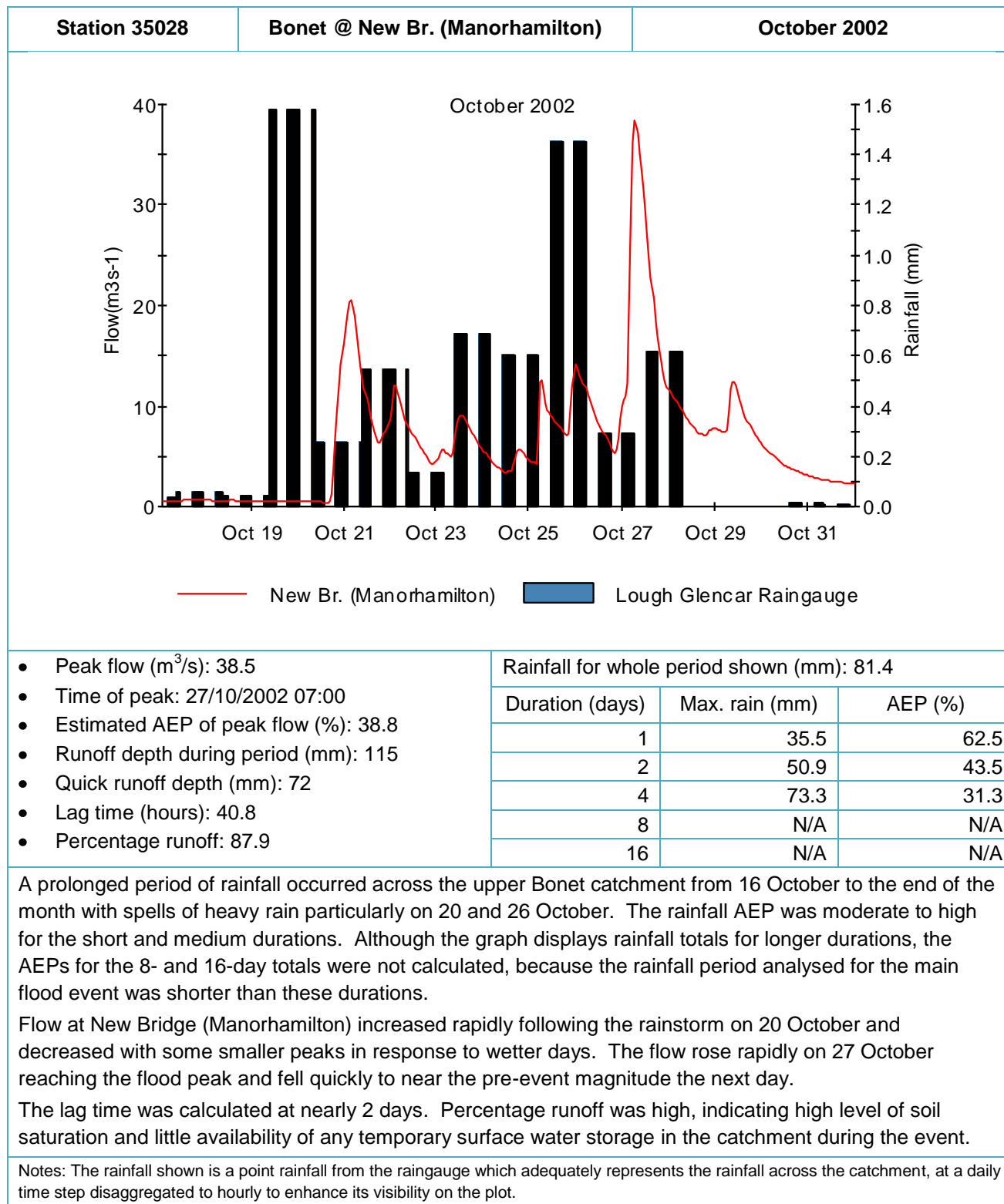
Flood event summary sheet



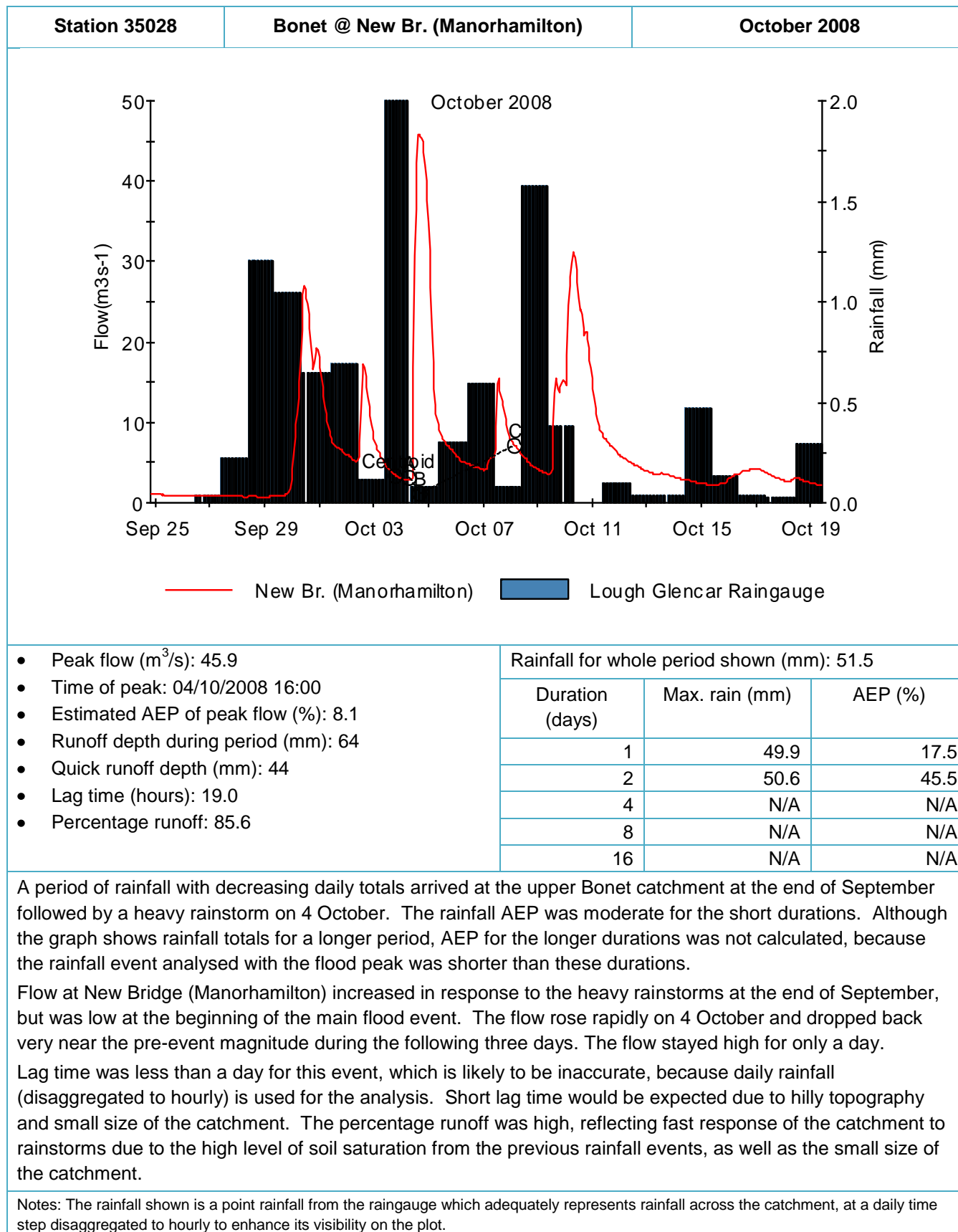
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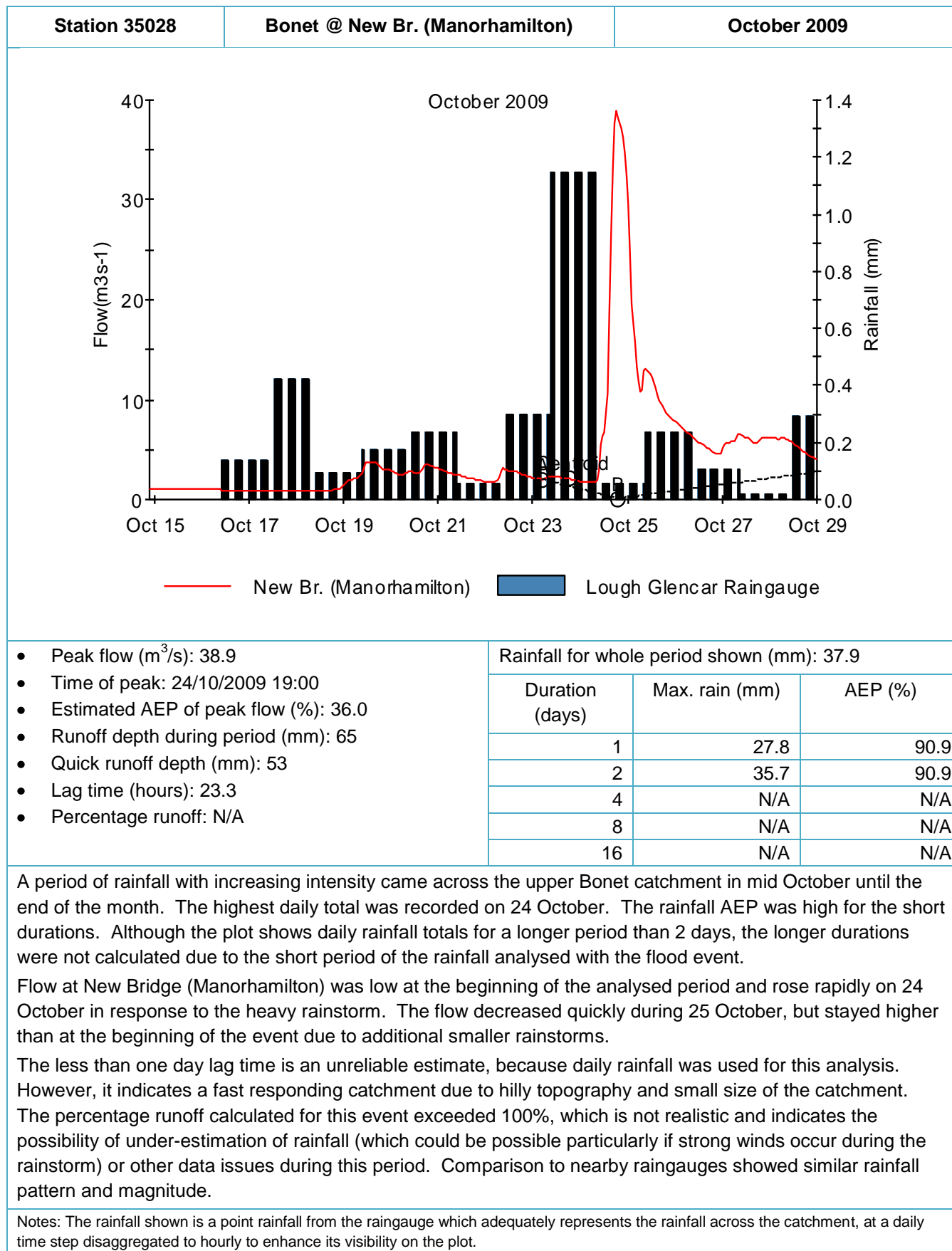
Flood event summary sheet



Flood event summary sheet



Flood event summary sheet



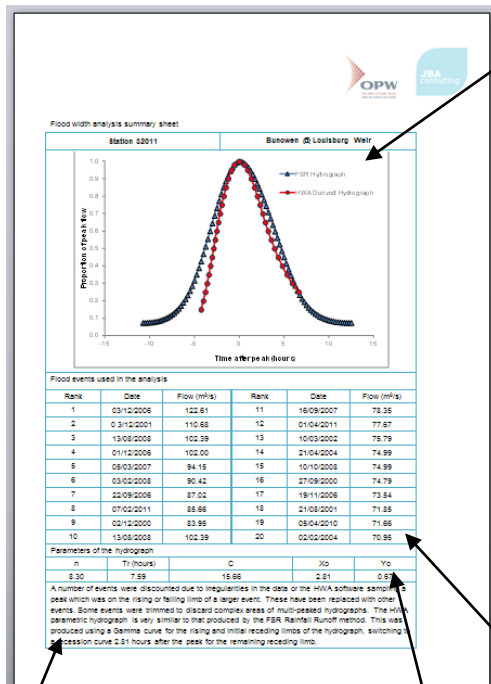
Appendix D – Event analysis



Introduction to Flood width analysis summary sheets

This appendix summarises the analysis of the widths of observed flood hydrographs. The results of this will be used in the next stage of the study to derive design flood hydrographs.

Information provided in the summary sheets



Flood hydrograph plot

The plot shows characteristic flood hydrographs, i.e. hydrographs that are standardised to peak at 1.0 and plotted so that the time origin is at the peak.

The “HWA derived hydrograph” is a mathematical function fitted to a set of median hydrograph widths from a large number of observed floods. HWA is Hydrograph Width Analysis, a computer program developed within work package 3.1 of the FSU research.

The “FSR hydrograph” is derived from the Flood Studies Report rainfall-runoff method, with model parameters estimated solely from catchment descriptors.

In comparing the two hydrographs it is important to be aware that the FSR hydrograph has the potential to be adjusted in order to give a better fit with the shape of observed events. This would be accomplished by estimating the time to peak parameter via a lag analysis, something which will be considered in the next stage of the study.

List of flood events

These are the events from which the HWA hydrograph was derived. The events initially selected for analysis were the highest 20 floods on record. This list was then refined to exclude events with missing data or events with multiple peaks which could not easily be separated, and other events were added to maintain a total of 20. As recommended in FSU WP3.1, some events were trimmed to discard complex areas of multi-peaked hydrographs. These 20 hydrographs were analysed to calculate their width at a range of percentiles of the peak flow. The median width was then calculated at each percentile, thus producing a derived hydrograph shape.

Parameters of the fitted hydrograph

This table lists the parameters of the mathematical function fitted to the derived flood hydrograph. Use of a parametric approach is recommended in FSU WP3.1 for studies with multiple flow estimation points such as CFRAMS. The parameters are:

n: Shape parameter of gamma function

Tr: Translation (location) parameter of gamma function

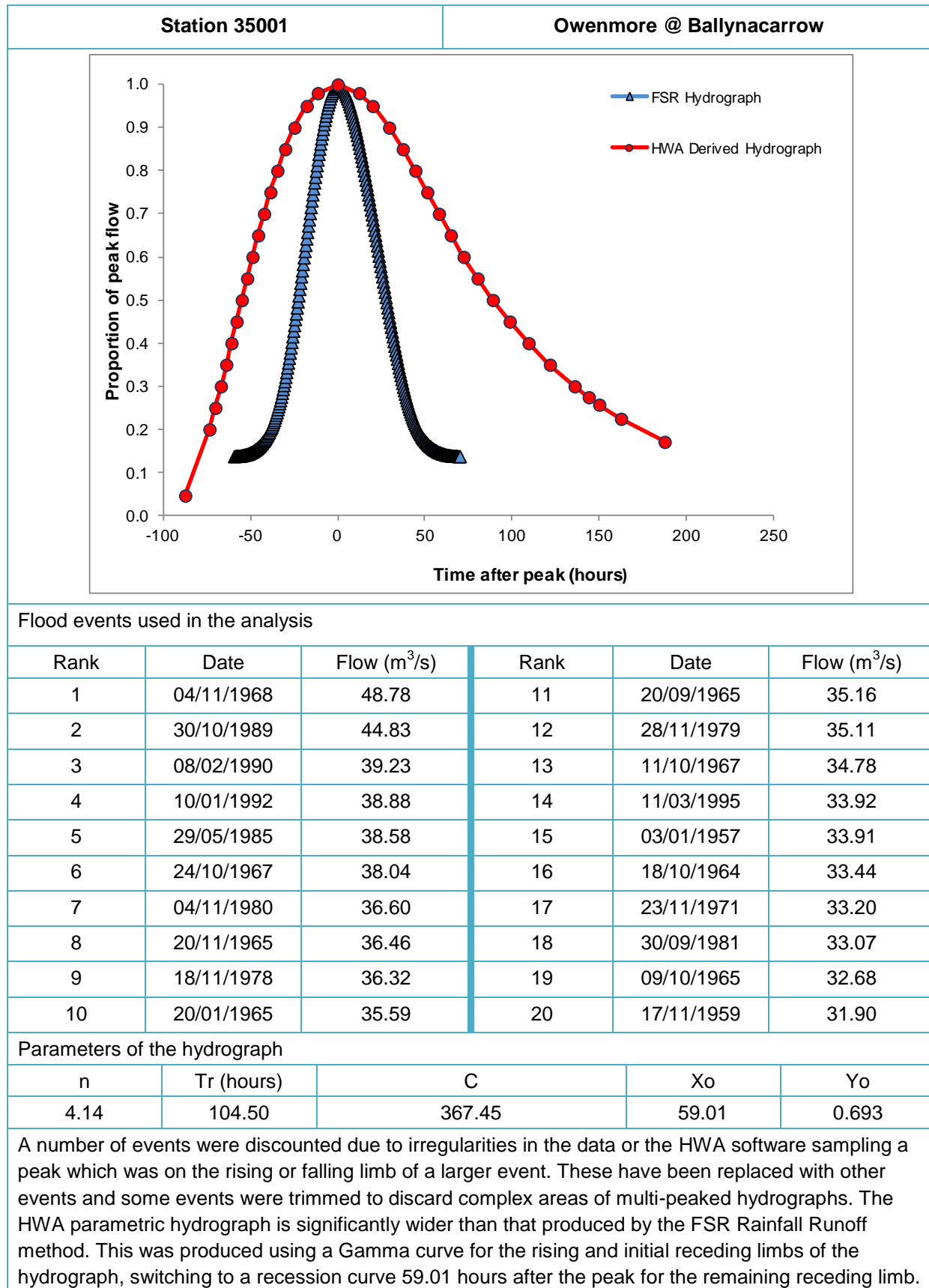
C: Parameter of the exponential function which is used to describe the recession part of the flood hydrograph

X₀, Y₀: Co-ordinates for the transition between the gamma and exponential functions. X₀ is the time after the peak (in hours) and Y₀ is the normalised flow at this time.

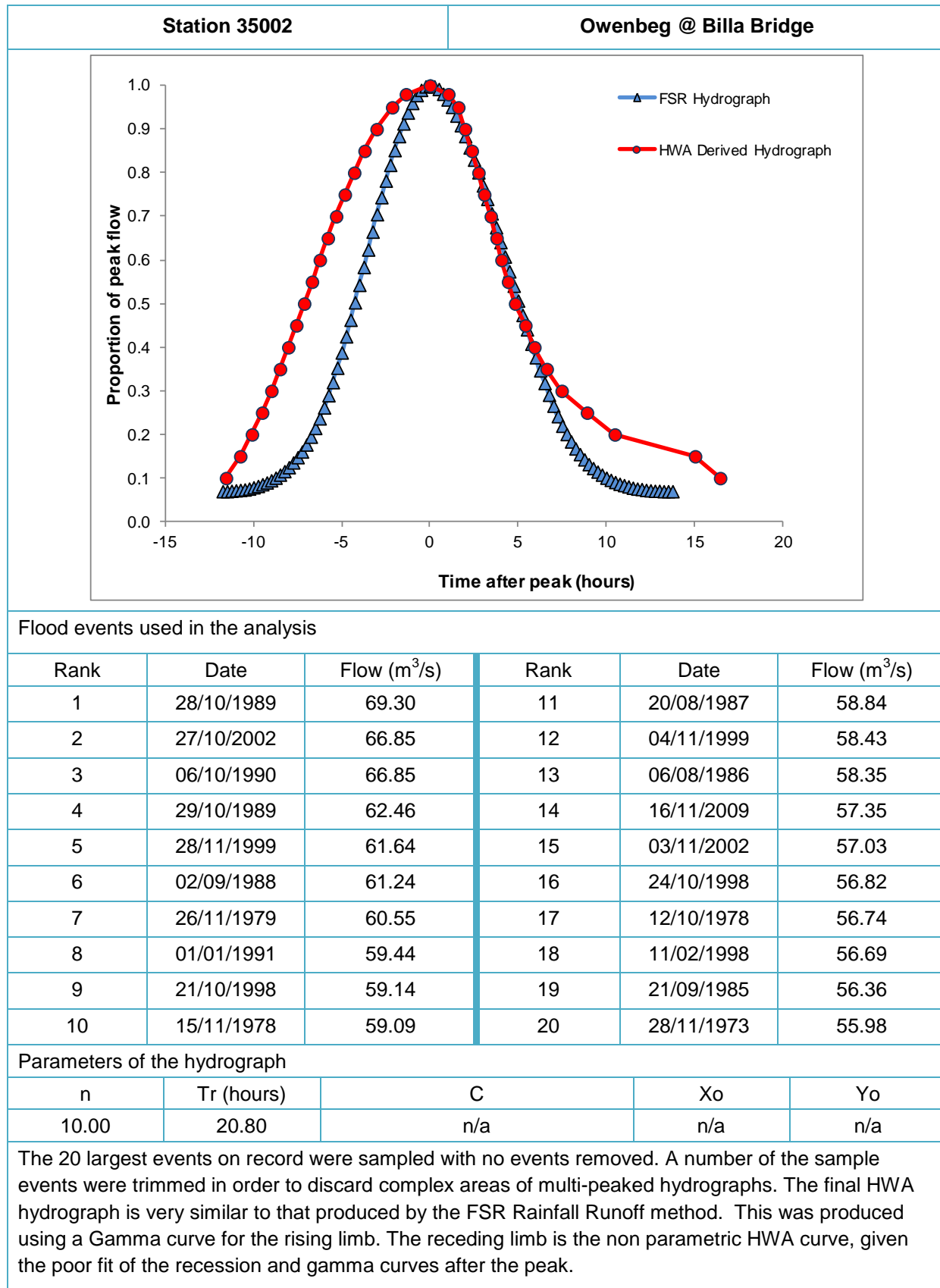
Commentary

Notes on the analysis.

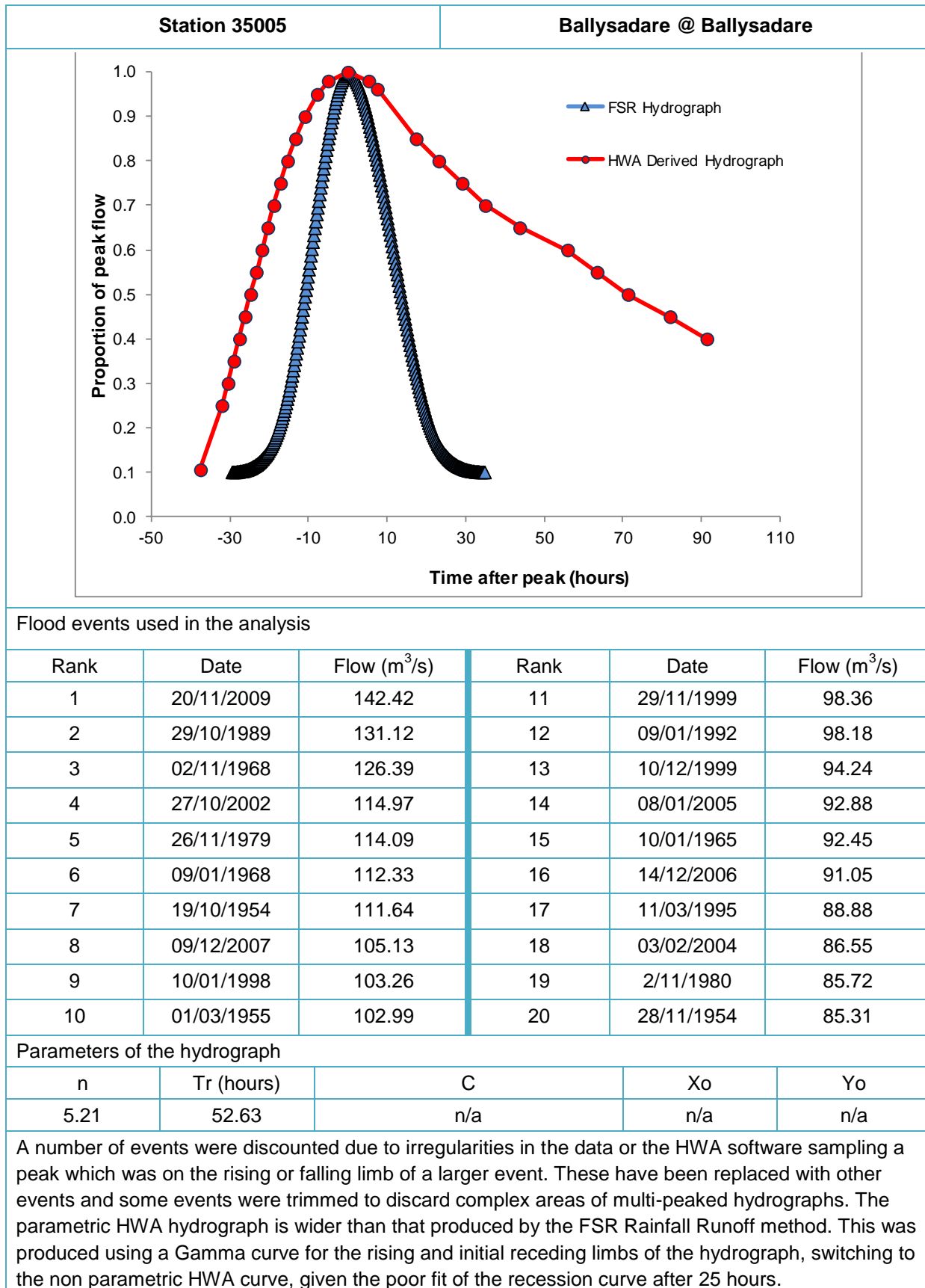
Flood width analysis summary sheet



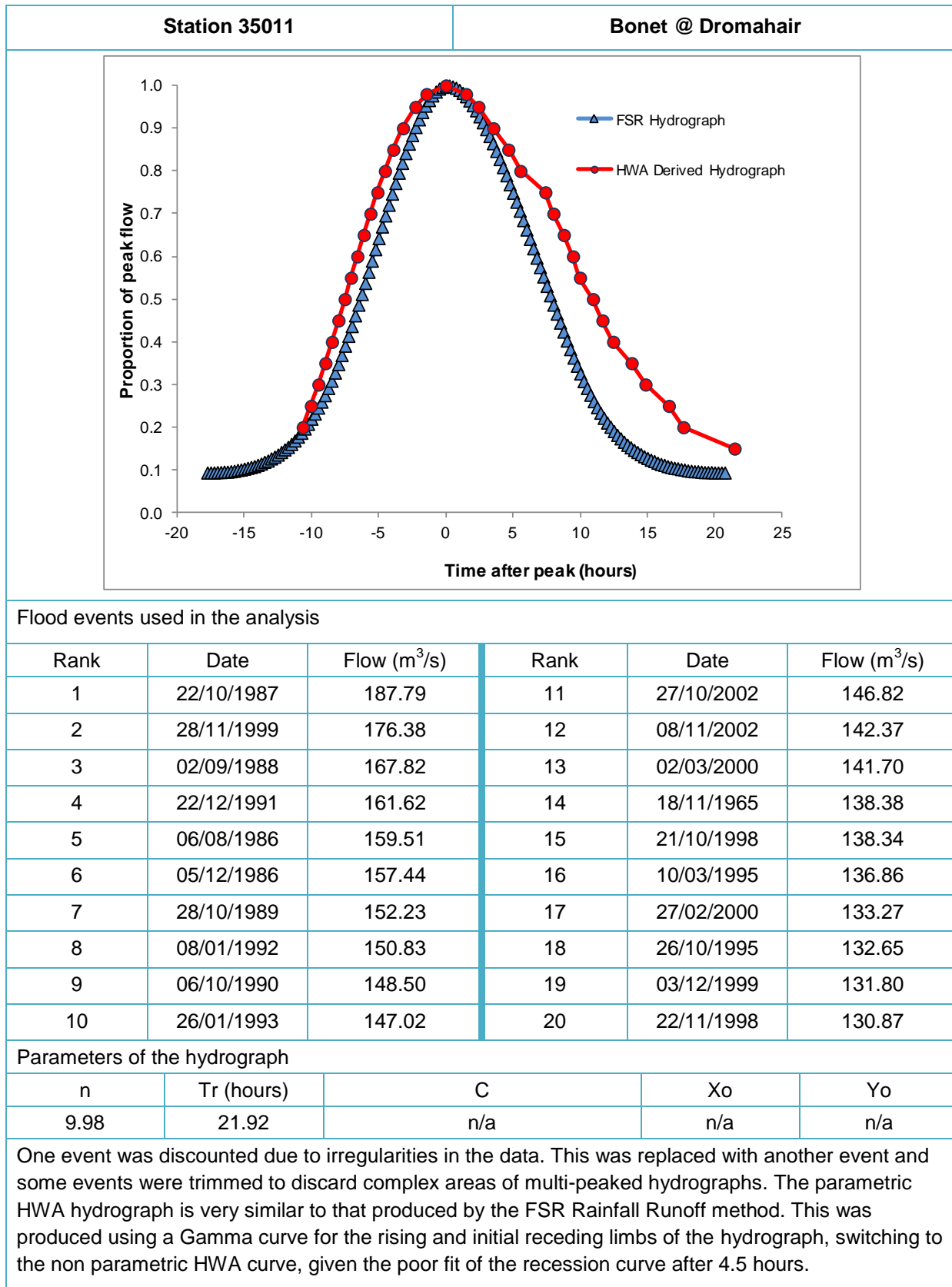
Flood width analysis summary sheet



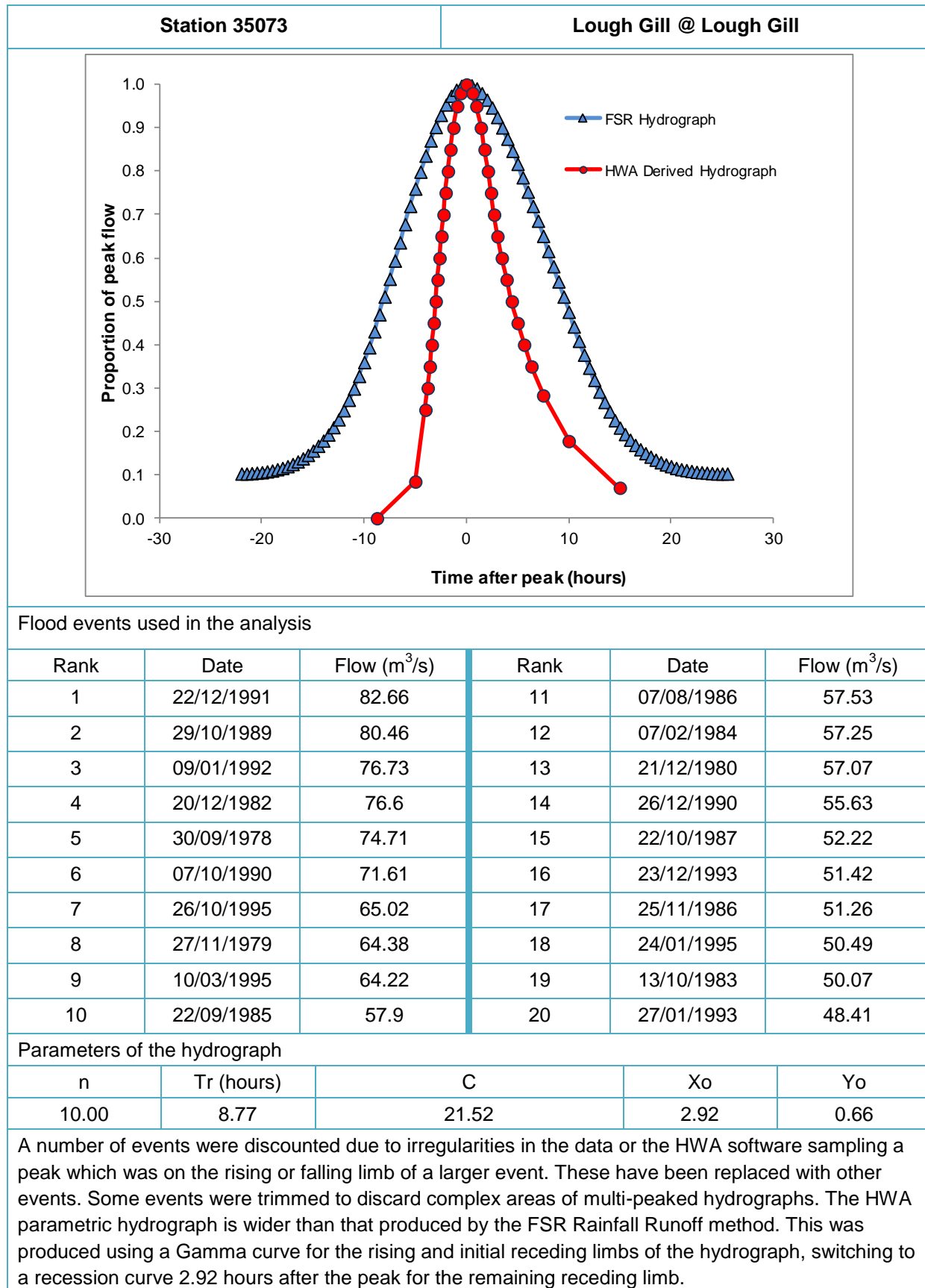
Flood width analysis summary sheet



Flood width analysis summary sheet



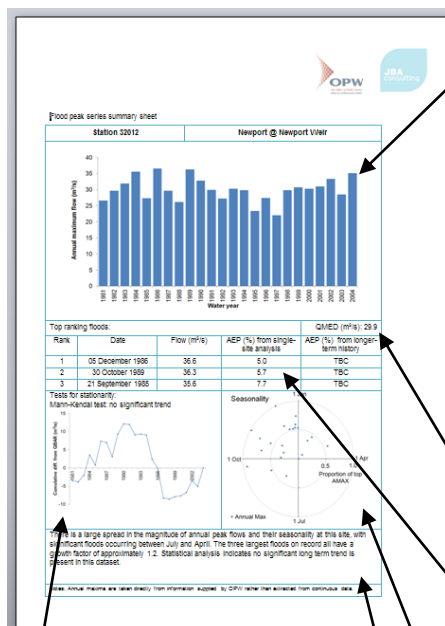
Flood width analysis summary sheet



Introduction to Flood peak analysis summary sheets

This appendix provides results from analysis of flood peak data at gauging stations which have the potential to provide reliable measurements of high flows and are located within or close to river reaches for which design flows are needed. A small number of gauges that provide only level data are also included.

Information provided in the summary sheets



Time series of annual maximum (AMAX) flows

The footnote gives the source of the data. Where AMAX have been provided by OPW or EPA, they are plotted in preference to peaks extracted from the continuous record. At some gauges no AMAX flow data was provided by OPW but it was available from the Flood Studies Update (FSU) research which developed rating equations for some stations where OPW or EPA do not have their own ratings. The FSU ratings were reviewed by OPW and are thought to be reasonable for calculation of AMAX flows. FSU AMAX have been included in the analysis where they are the only source of data.

All AMAX are for water years, which start on 1 October.

At some gauges the AMAX flows are likely to change as a result of the rating equation extension work being carried out within this project.

QMED

The median of the AMAX flows.

Analysis of top-ranking floods

The annual exceedance probability (AEP) for the three highest magnitude AMAX events is estimated from single-site analysis, which is described on the second page of the summary sheet. This analysis is not available for level-only gauges or for flow gauges with short records.

Seasonality graph

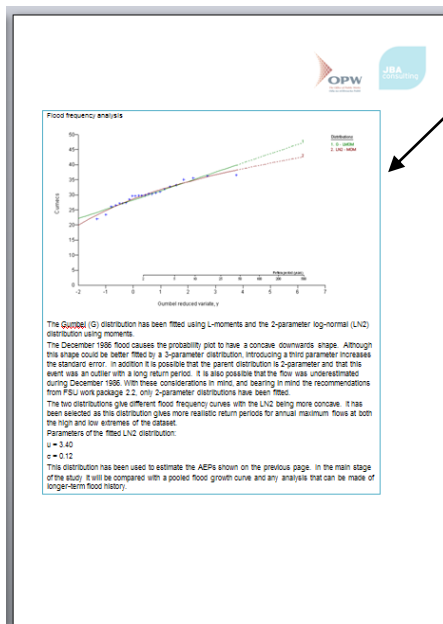
This circular plot illustrates the seasonality of the AMAX flows. Each AMAX is represented by a dot. Radial distance round the circle indicates the time of year and the distance from the centre represents the relative magnitude of the event so that the largest event plots at the edge of the circle.

Commentary

A brief description of the analysis, highlighting any notable features of the flood peak dataset.

Tests for stationarity

Flood frequency analysis normally makes the assumption that each AMAX comes from the same underlying distribution. To help test this assumption the data are checked for a progressive trend using the Mann-Kendall test and for sudden step changes using a plot showing the cumulative difference between each AMAX and the overall mean, QBAR. A step change is indicated by a change from consistently positive to consistently negative slope, or vice versa, with a run of several years either side of the change.



Flood frequency analysis

This section is provided only for gauges with at least 10 years of AMAX data.

The graph shows single-site flood frequency curves fitted to the AMAX data. The x axis is the Gumbel reduced variate, with a parallel axis showing the equivalent return period, T. This can be converted to annual exceedance probability, AEP, expressed as a percentage, using $AEP = 100/T$.

Two curves are shown, representing the Gumbel (EV1) and 2-parameter log normal (LN2) distributions. These two distributions are recommended for single-site analysis in the report on FSU work package 2.2. They are fitted using the recommended methods: L-moments for EV1 and moments for LN2, applied within the WINFAP-FEH software Version 3.0.003)

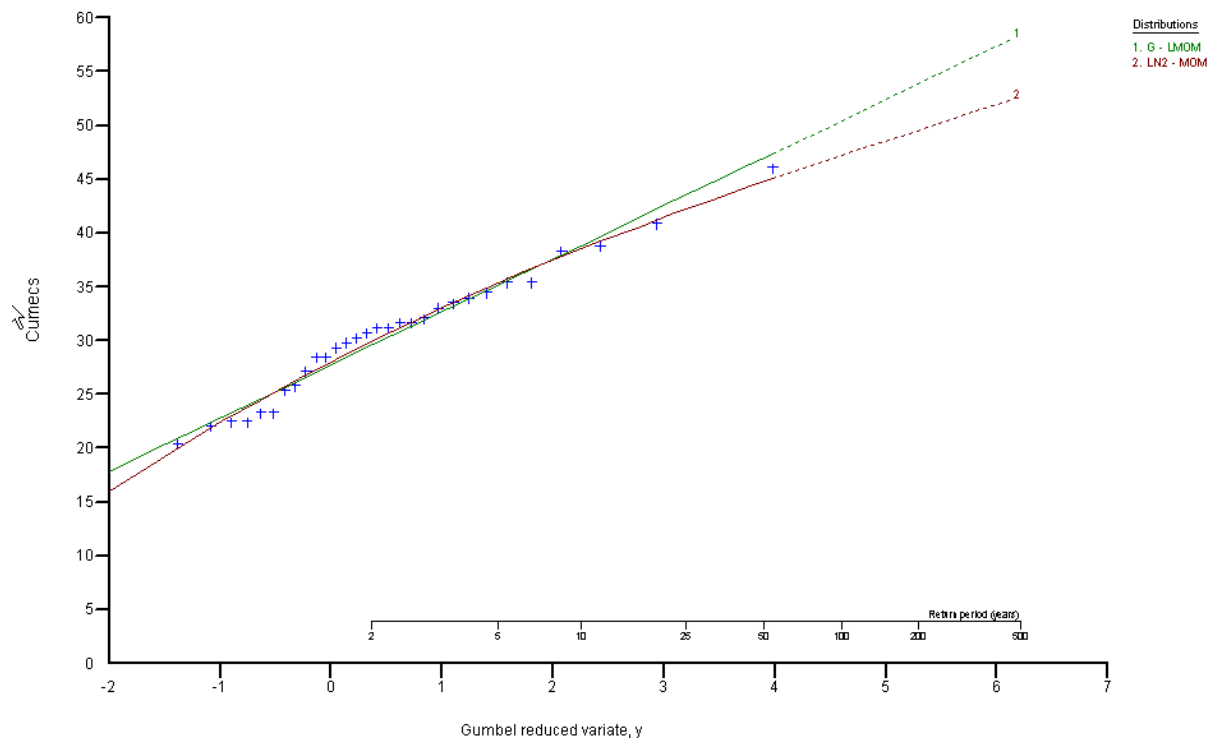
The text below describes the analysis and explains which distribution has been selected as the preferred flood frequency curve. The parameters of this distribution are given.

In the main stage of the study these single-site flood frequency curves will be compared with pooled flood growth curves and any analysis that can be made of longer-term flood history.

Flood peak series summary sheet

| Station 35001 | | | Owenmore @ Ballynacarrow | |
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Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

The probability plot of annual maximum flows shows a slight concave downward curvature. A 3-parameter distribution would give a better fit to this sample of data. However, introducing a third parameter increases the standard error. In addition it is possible that the parent distribution is 2-parameter and that it is only by chance that there have not been any exceptional floods during the period of record. With these considerations in mind, and bearing in mind the recommendations from FSU work package 2.2, only 2-parameter distributions have been fitted.

Either the Gumbel or log-normal distribution appears to be a reasonable fit to the sample of annual maximum flows. They give similar flood frequency curves. The LN2 distribution has been selected as it gives the best fit to flood peak data at both the low and high extreme peak flows.

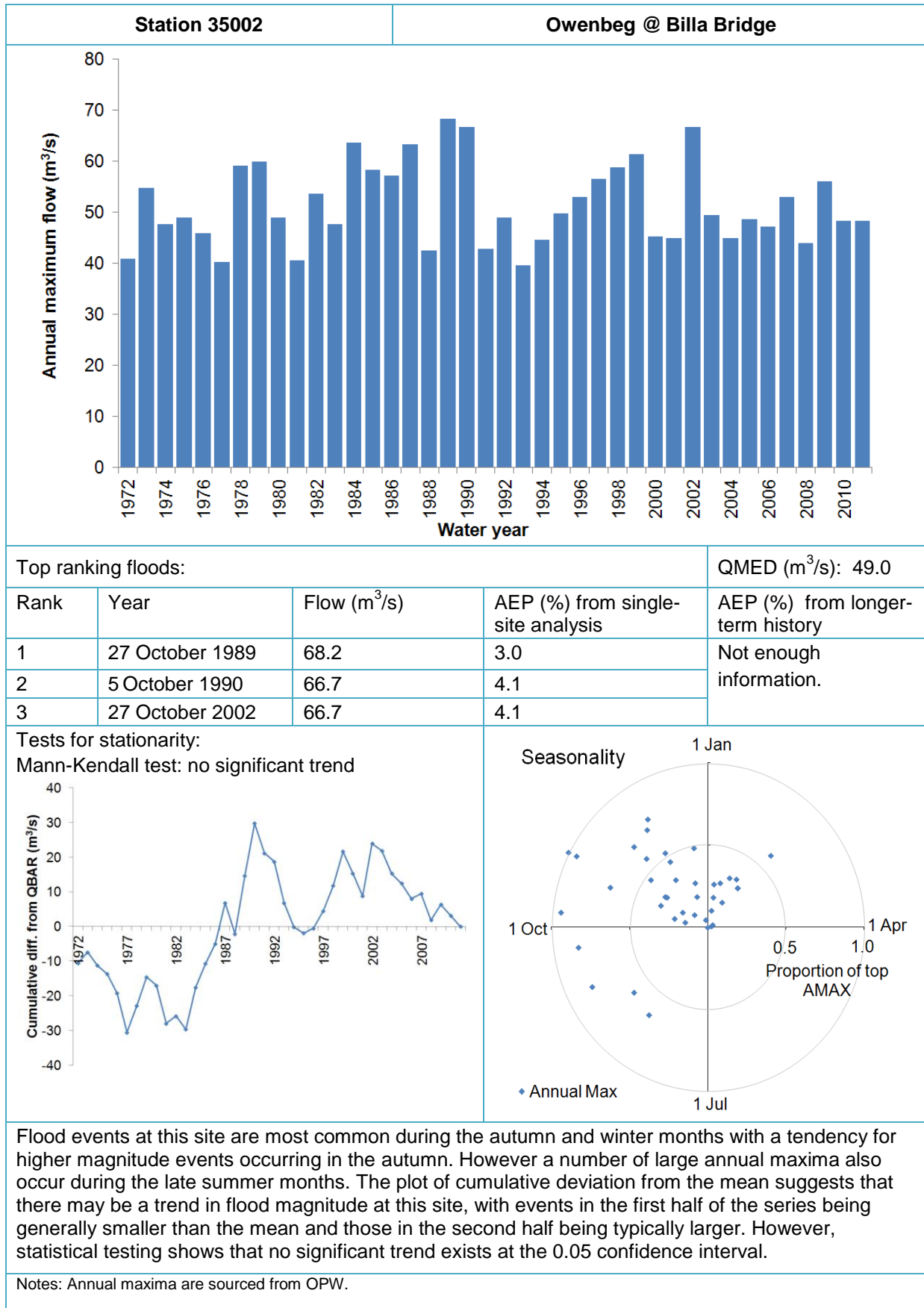
Parameters of the fitted LN2 distribution:

$$u = 3.40$$

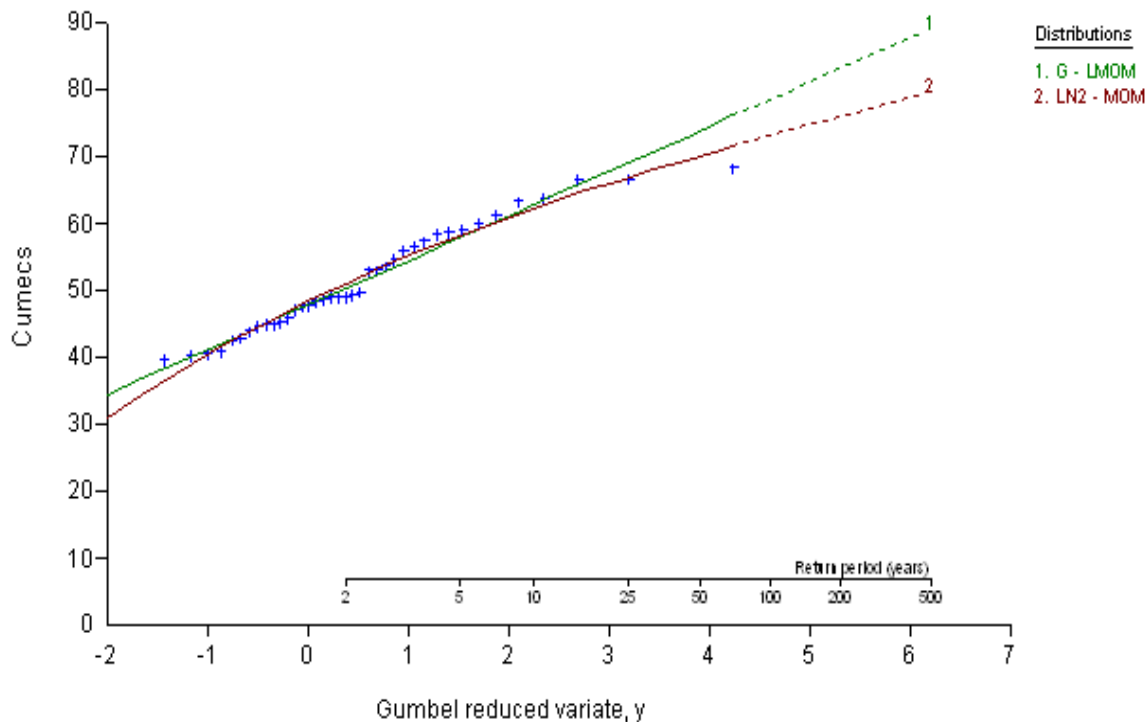
$$\sigma = 0.195$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve and any analysis that can be made of longer-term flood history.

Flood peak series summary sheet



Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

The probability plot may be best fitted using a 3-parameter distribution, but this method introduces a third parameter and increases the standard error. In addition, the flows associated with the four highest magnitude peak flows may have been underestimated. With these considerations in mind, and bearing in mind the recommendations from FSU work package 2.2, only 2-parameter distributions have been fitted.

The two distributions give similar flood frequency curves, but the LN2 distribution has been selected as it gives a more reasonable return period for these highly ranked events.

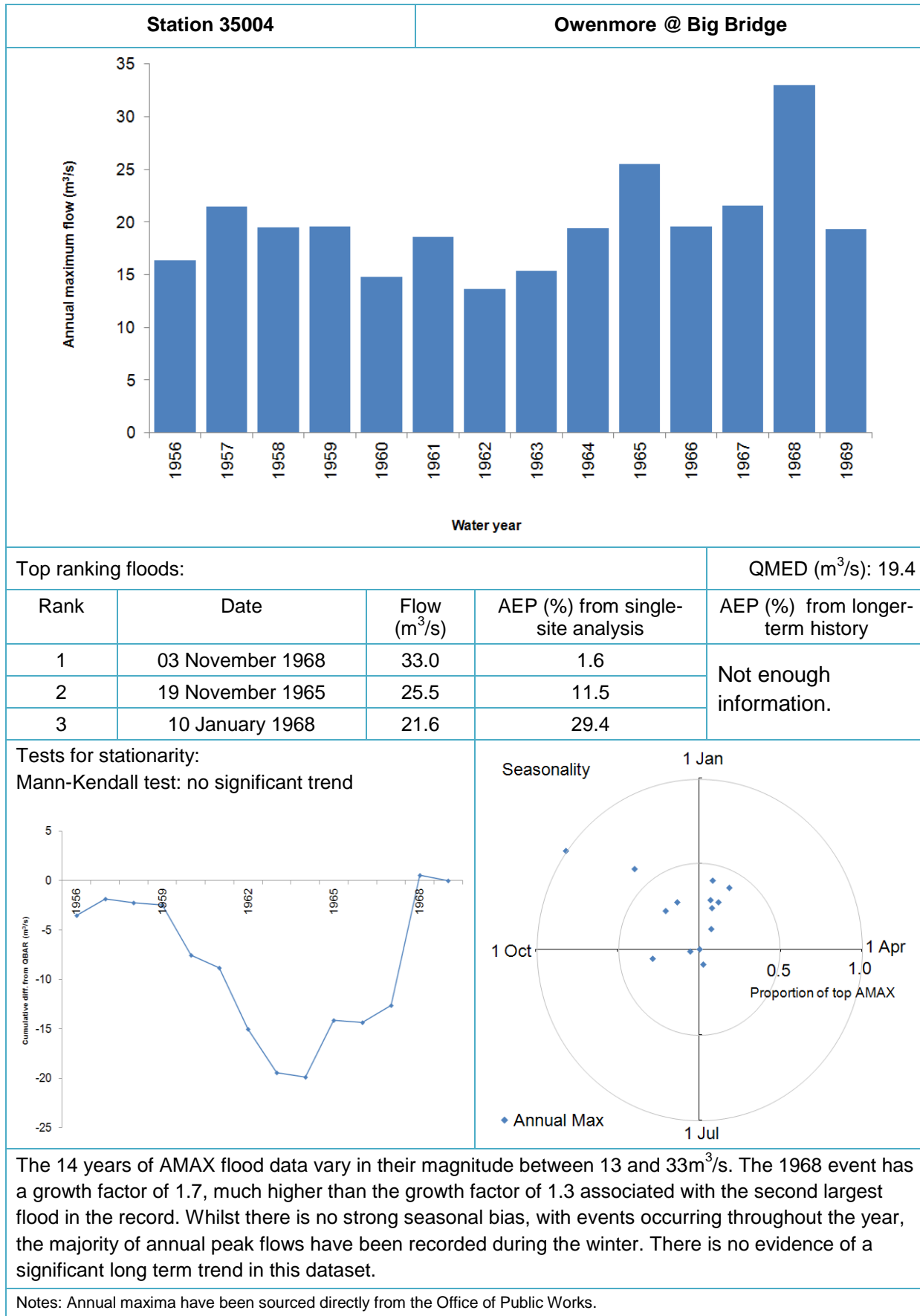
Parameters of the fitted LN2 distribution:

$$u = 3.93$$

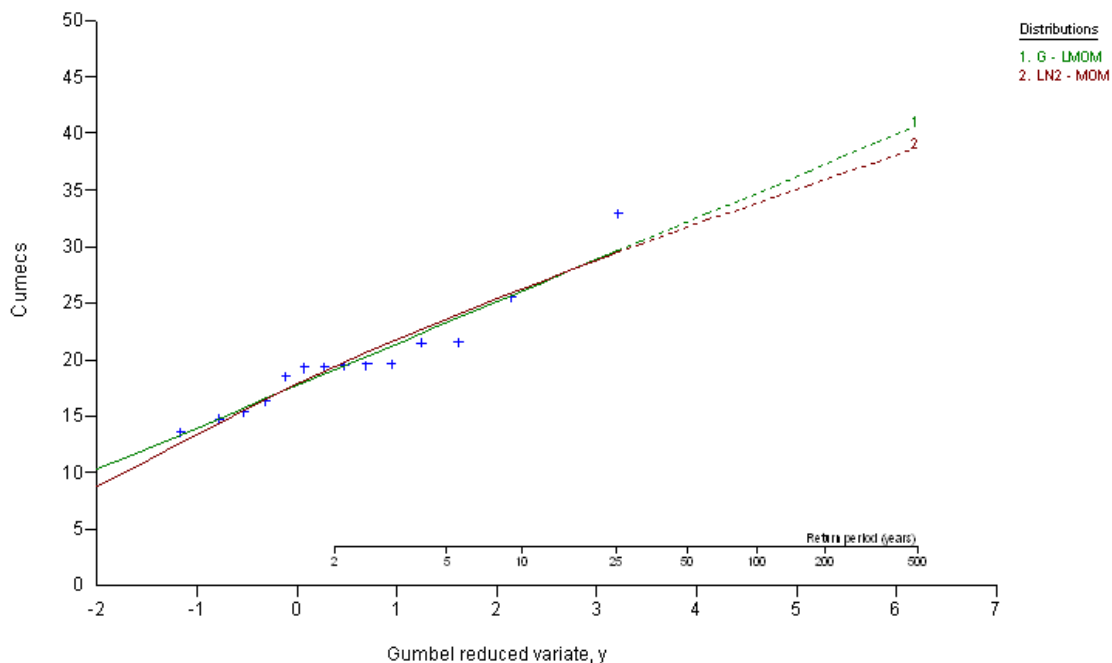
$$\sigma = 0.16$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve and any analysis that can be made of longer-term flood history.

Flood peak series summary sheet



Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

The probability plot of annual maximum flows shows a slight concave upward curvature. A 3-parameter distribution would give a better fit to this sample of data. However, introducing a third parameter increases the standard error. In addition it is possible that the parent distribution is 2-parameter and that it is only by chance that there have not been any exceptional floods during the period of record. With these considerations in mind, and bearing in mind the recommendations from FSU work package 2.2, only 2-parameter distributions have been fitted.

Either the Gumbel or log-normal distribution appears to be a reasonable fit to the sample of annual maximum flows. They give similar flood frequency curves. The Gumbel has been selected as it has been found to give an acceptable fit to flood peak data at a larger number of stations in Ireland (FSU work package 2.2) and is more representative of the lower annual maximum flows, for example December 1962.

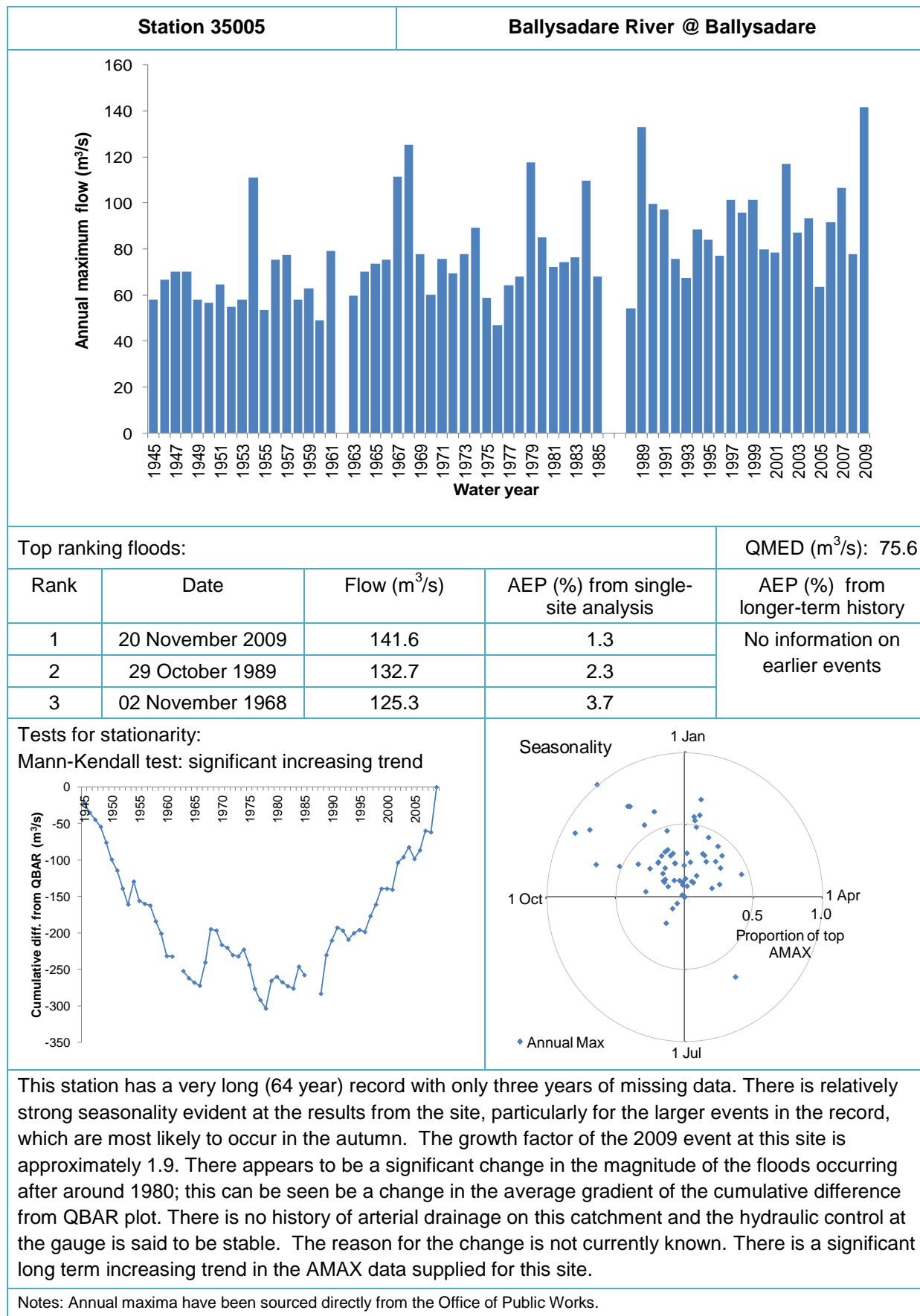
Parameters of the fitted Gumbel distribution:

$$u = 17.69$$

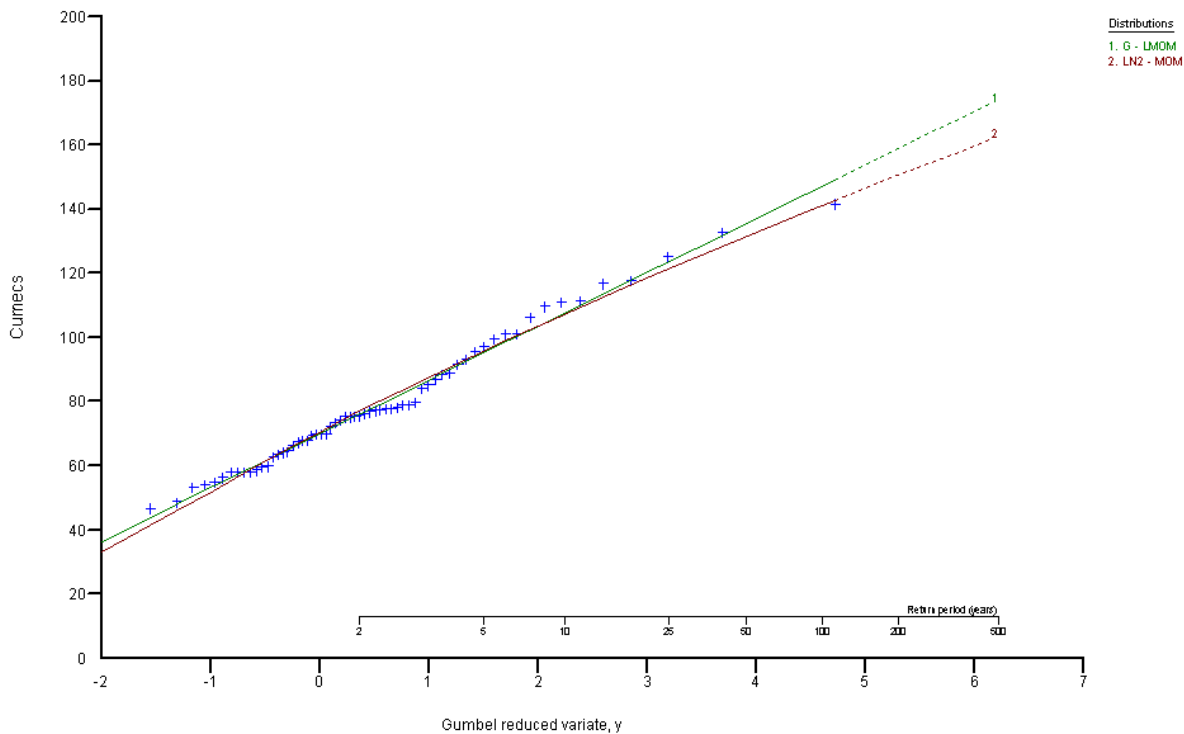
$$\alpha = 3.71$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve and any analysis that can be made of longer-term flood history.

Flood peak series summary sheet



Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

Either the Gumbel or log-normal distribution appears to be a reasonable fit to the sample of annual maximum flows. They give similar flood frequency curves. The Gumbel has been selected as it has been found to give an acceptable fit to flood peak data at a larger number of stations in Ireland (FSU work package 2.2).

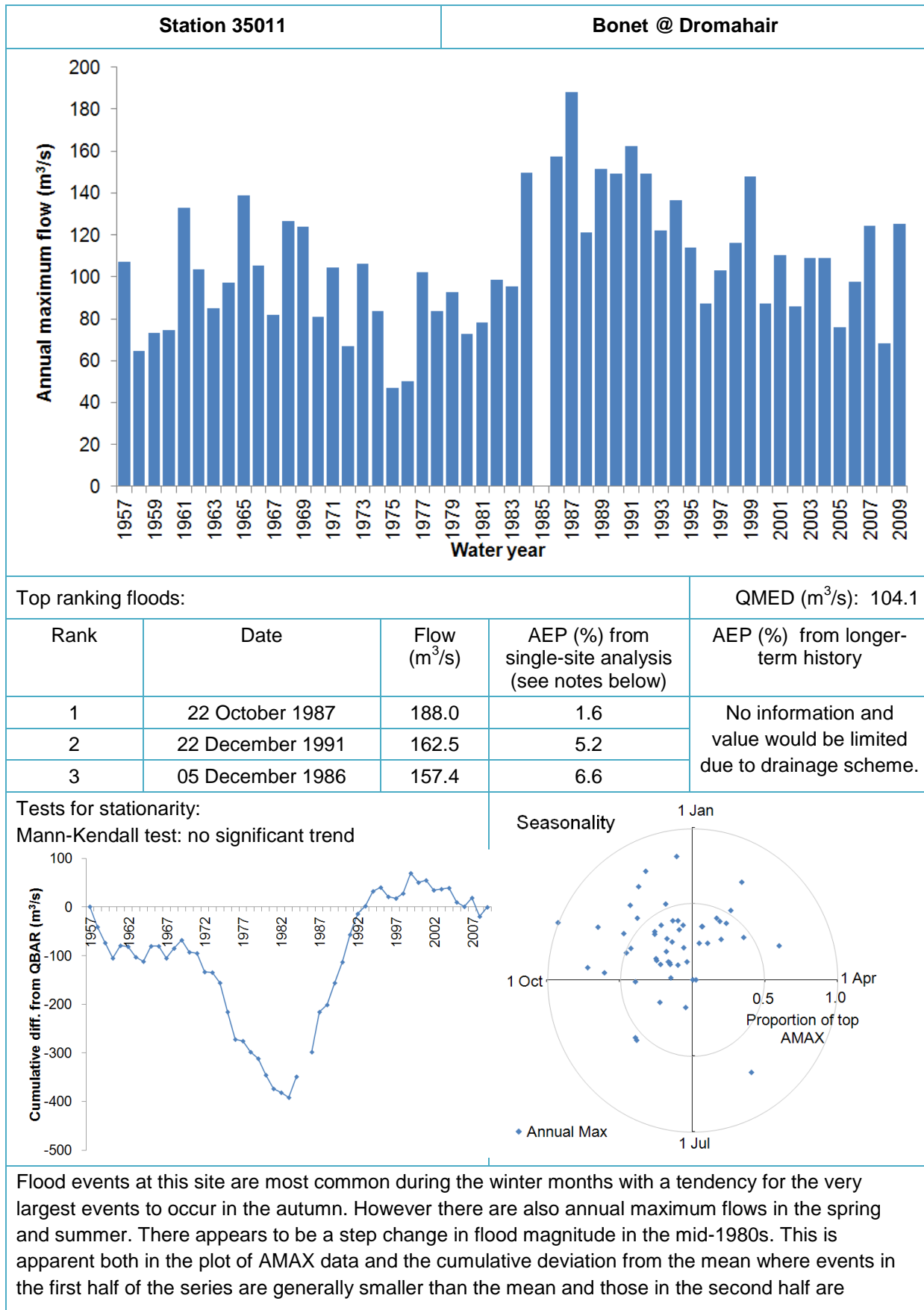
Parameters of the fitted Gumbel distribution:

$$u = 70.0$$

$$\alpha = 16.8$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve and any analysis that can be made of longer-term flood history.

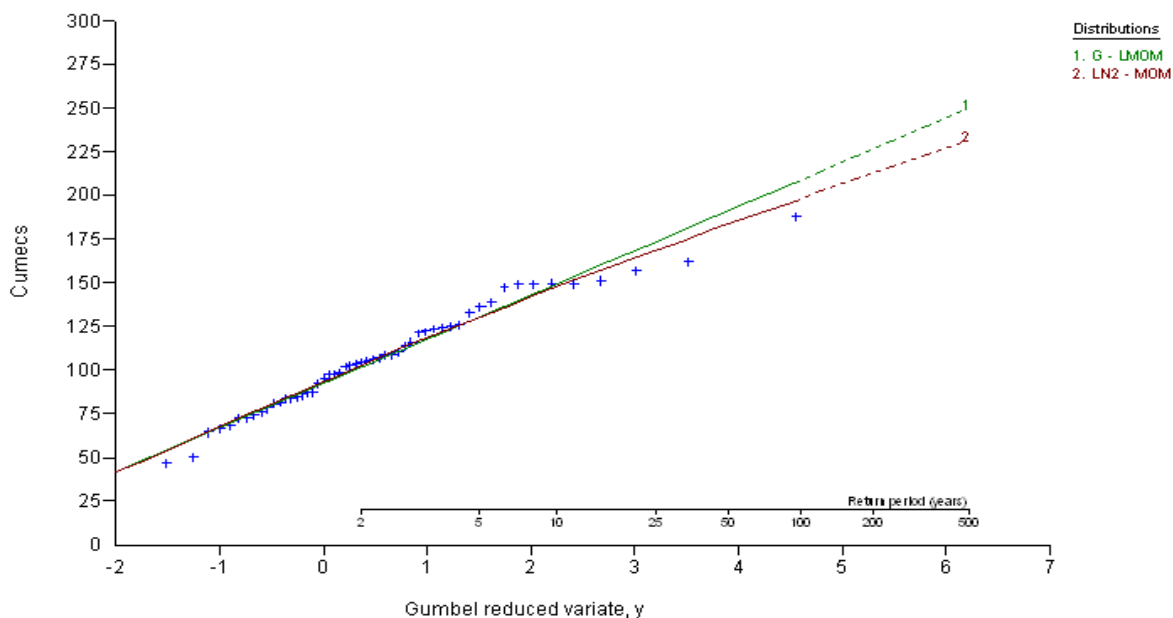
Flood peak series summary sheet



typically larger. This is a result of an arterial drainage scheme implemented during 1982-1992 which causes the AMAX data to increase in magnitude immediately after drainage and then gradually reduce as the channel attempts to dynamically adjust towards a new equilibrium profile. This step change limits the value of the data for flood frequency analysis since the assumption of identically distributed data values does not hold true. The estimated AEP values in the above table should be interpreted with caution. Because there is no AFA in the vicinity, this gauging station will not play an important role in flood estimation within the CFRAM.

Notes: Annual maxima have been sourced directly from the Office of Public Works.

Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

The probability plot of annual maximum flows shows a slight concave downward curvature. A 3-parameter distribution would give a better fit to this sample of data. However, introducing a third parameter increases the standard error. In addition it is possible that the parent distribution is 2-parameter and that it is only by chance that there have not been any exceptional floods during the period of record. With these considerations in mind, and bearing in mind the recommendations from FSU work package 2.2, only 2-parameter distributions have been fitted.

Either the Gumbel or log-normal distribution appears to be a reasonable fit to the sample of annual maximum flows. They give similar flood frequency curves. The LN2 has been selected as it provides a more realistic fit for the higher magnitude events.

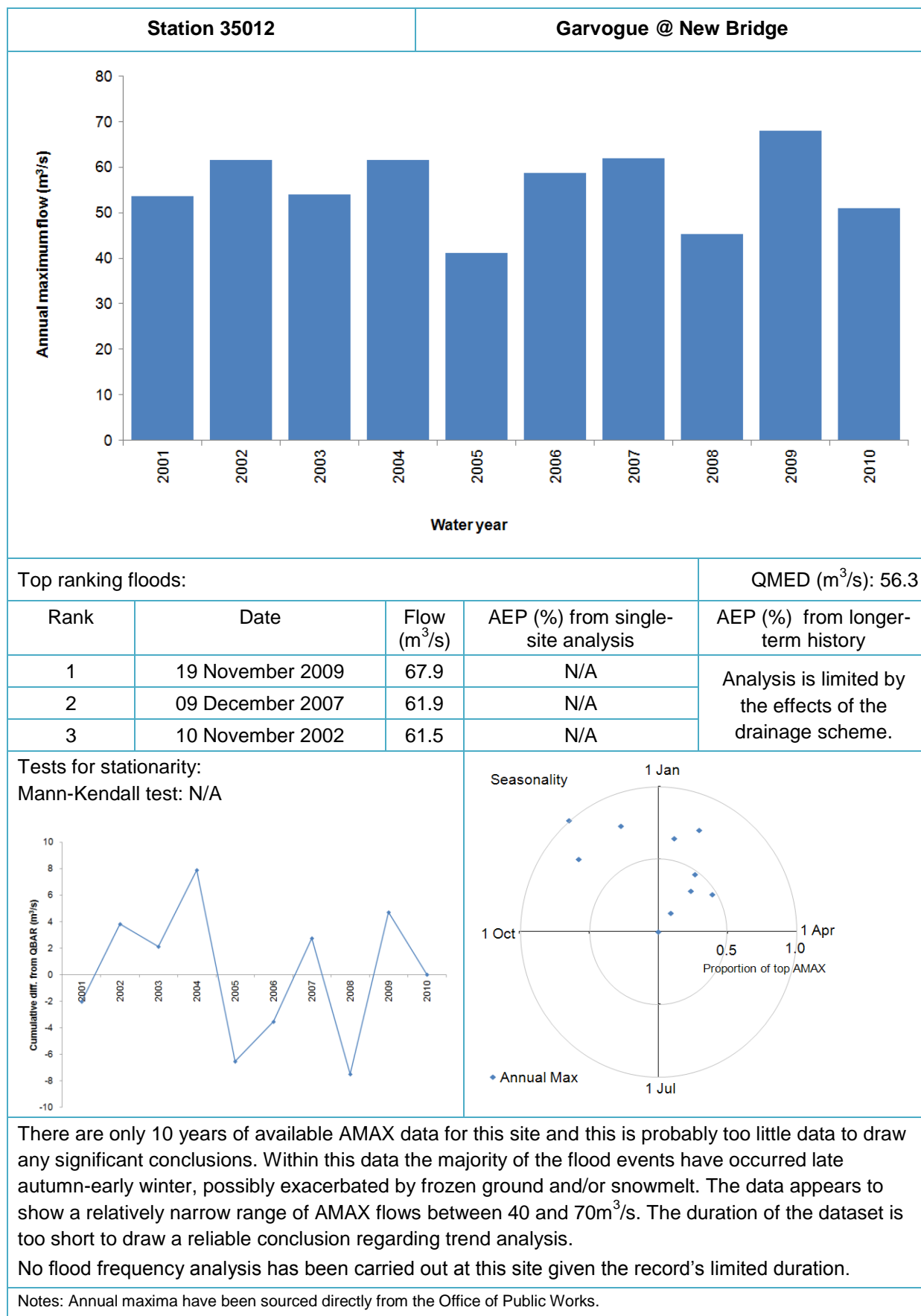
Parameters of the fitted LN2 distribution:

$$u = 4.63$$

$$\sigma = 0.28$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve and any analysis that can be made of longer-term flood history.

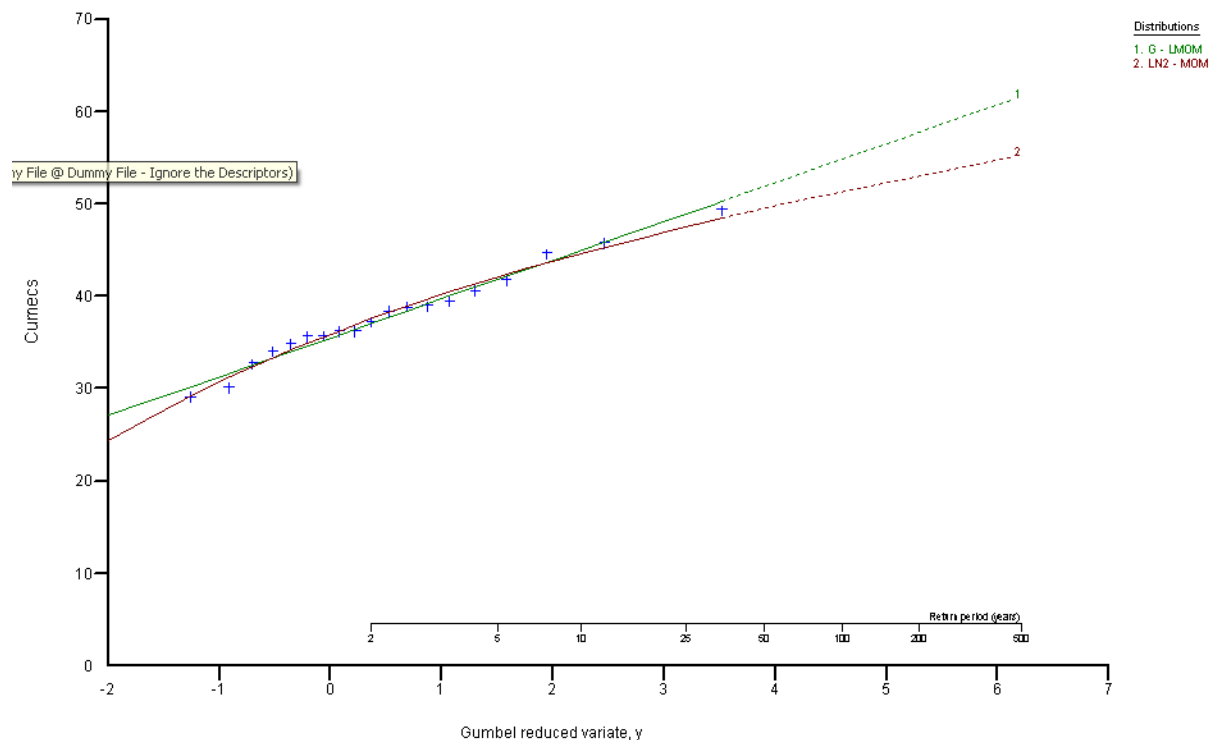
Flood peak series summary sheet



Flood peak series summary sheet

| Station 35028 | | | Bonet @ New Bridge (Manorhamilton) | |
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Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

Either the Gumbel or log-normal distribution appears to be a reasonable fit to the sample of annual maximum flows. They give similar flood frequency curves. The Gumbel has been selected as it has been found to give an acceptable fit to flood peak data at a larger number of stations in Ireland (FSU work package 2.2). It is also more representative of the three top ranking floods.

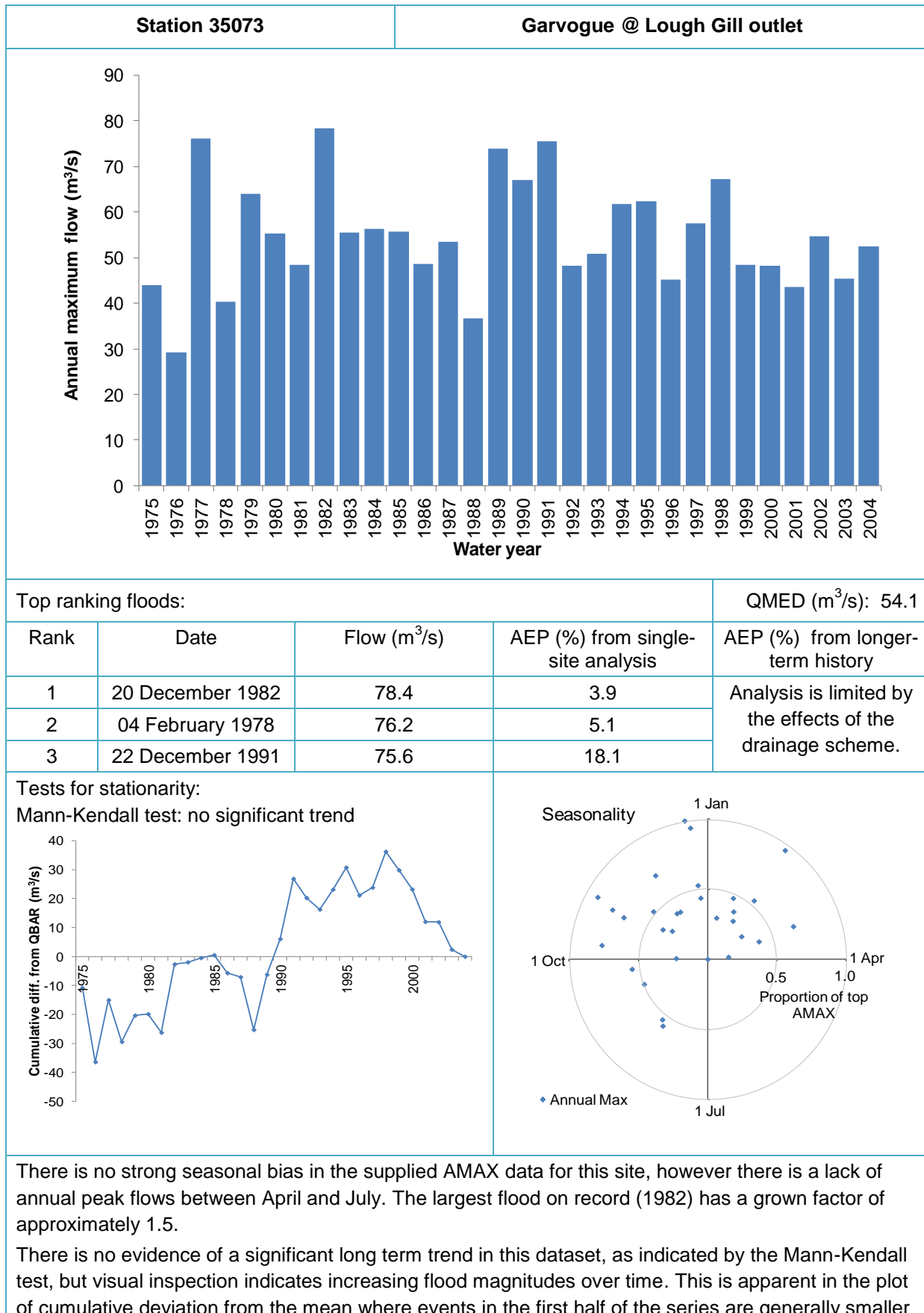
Parameters of the fitted Gumbel distribution:

$$u = 35.5$$

$$\alpha = 4.21$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve and any analysis that can be made of longer-term flood history.

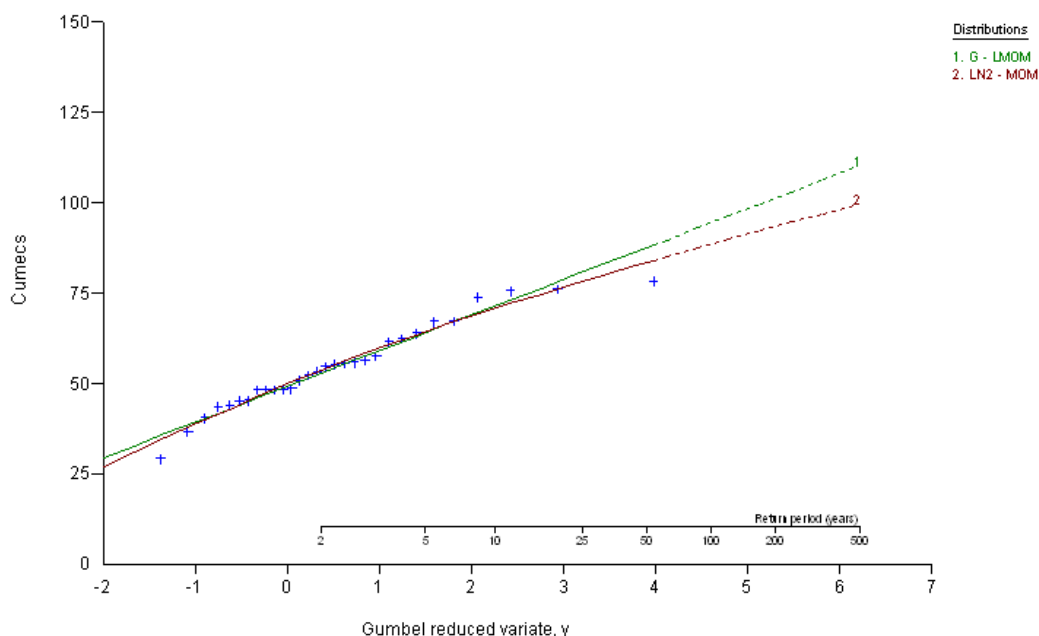
Flood peak series summary sheet



than the mean and those in the second half are typically larger. This is a result of an arterial drainage scheme implemented during 1982-1992 which causes the AMAX data to increase in magnitude immediately after drainage and then gradually reduce as the channel attempts to dynamically adjust towards a new equilibrium profile. The same scheme has affected the upstream site at Dromahair (35011) which illustrates a more exacerbated response than at site 35073 which experiences a reduced impact upon flows as a result of high water attenuation in Lough Gill. This scheme may therefore prevent use of this data for reliably estimating flood frequency given the non-stationary nature of the time series.

Notes: Annual maxima are sourced from the Flood Studies Update Programme. Their magnitudes are very close to AMAX flows held by the EPA. However the AMAX record produced by the FSU extends beyond 1997 which is the end date of EPA's flow record at this gauge, classed as level-only since 1997. There is no obvious change in 1997 which might preclude use of the more recent flood peak data.

Flood frequency analysis



The Gumbel (G) distribution has been fitted using L-moments and the 2-parameter log-normal (LN2) distribution using moments.

The probability plot may be best fitted using a 3-parameter distribution, but this method introduces a third parameter and increases the standard error. In addition, the flows associated with the December 1982 peak flow may have been underestimated. With these considerations in mind, and bearing in mind the recommendations from FSU work package 2.2, only 2-parameter distributions have been fitted.

The two distributions give similar flood frequency curves, but the LN2 distribution has been selected as it gives a more reasonable return period for the low and high extreme peak flows.

Parameters of the fitted LN2 distribution:

$$u = 3.98$$

$$\sigma = 0.22$$

This distribution has been used to estimate the AEPs shown on the previous page. In the main stage of the study it will be compared with a pooled flood growth curve.

Flood chronology

This appendix provides results from analysis of flood history for UoM 35. Historic flood records were collected from sources such as local newspapers, previous studies, OPW's National Flood Hazard Mapping website, publications on flood history and other relevant websites. Dates and magnitude of more recent events were obtained from hydrometric records. The information was reviewed in order to provide qualitative and, where possible, also quantitative information on the longer-term flood history in the area.

The table below gives a chronology of flood events, including information on their impacts.

| Date | Catchment/ river | Details |
|-------------------------------|---------------------|--|
| 27 August 1910 | Collooney | Heavy rainstorm was recorded at Captain Cooper's observatory near Collooney from noon on Thursday to 9am yesterday, being the heaviest rainfall recorded there for 50 years; River Boyle south east of the Ballysadare catchment was out of bank, causing "the worst flooding in living memory". |
| 28 th October 1954 | Riverstown | Crops damaged by flooding from River Arrow in the Riverstown area. |
| November 1999 | Riverstown | Water treatment plant and Colbrook estate experienced flooding. |
| 11 th June 2007 | Sligo | Flooding in Adelaide St, Market Yard, Knappagh Rd. Cranmore Place, Larkhill Rd and Cleveragh Rd. |
| November 2009 | Sligo | Flooding in Sligo Strandhill area along the coastline. |
| | Ballysadare | Highest gauged flow on record (1945 to date) at Ballysadare and yet no reports of flood damage. |

Based on the outcomes of the analysis, a flood history time line was produced. The time line provides an overview of the main flooding events by putting together key events extracted from the available hydrometric data (usually limited to the top three events indicated by rank 1-3), and the events identified in the collated information on historic flooding. The time line sheet also includes locations of the flood events and indicates spatial distribution of these locations (i.e. downstream or upstream along a watercourse).

Four levels of flood severity are used in the table, namely "Severe", "Significant", "Minor" and "Unknown" classifications. These are indicative only and are based on the available quantitative and qualitative flood history information. The table over the page provides details of the classification.

Appendix G – Flood history



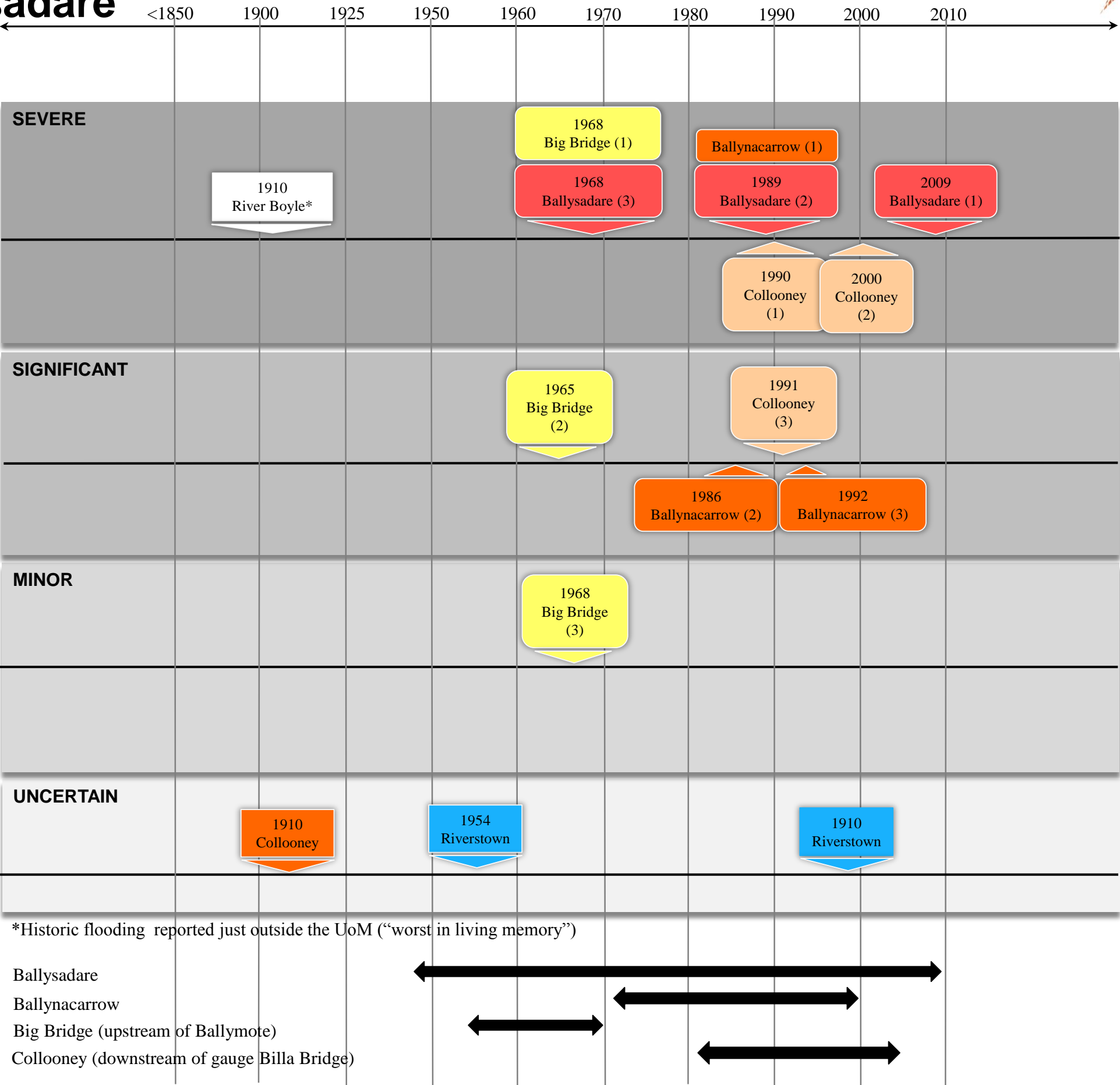
| Flood severity classification | AEP (from available data) | Flood severity from historic information |
|-------------------------------|---------------------------|---|
| Severe | < 4% | Greatest flood in more than 25 years and/or widespread flooding covering area |
| Significant | 4% - 10% | Widespread flooding |
| Minor | > 10% | Other |
| Uncertain | N/A | Other |

UoM 35 – Ballysadare

Artificial influence:

Drainage

Flood events:



UoM 35 – Bonet

