



North Western Neagh Bann CFRAM Study

Final Report

Unit of Management 01

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ABBREVIATIONS

AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
BCR	Benefit Cost Ratio
CFRAM	Catchment Flood Risk Assessment and Management
FHRC	Flood Hazard and Research Centre
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
HEFS	High end future scenario
ICM	Integrated Catchment Management
KMM	Kirk McClure Morton
MCM	Multi Coloured Manual
MPW	Medium Priority Watercourse
MRFS	Mid range future scenario
OPW	Office of Public Works
OSi	Ordnance Survey ireland
PFRA	Preliminary Flood Risk Assessment
POR	Preliminary Options Report
PVb	Present Value benefit
PVd	Present Value damage
RBD	River Basin District
SEA	Strategic Environmental Assessment
SI	Statutory Instrument
SoP	Standard of Protection
SSA	Spatial Scale of Assessment
SUDS	Sustainable Urban Drainage Systems
UoM	Unit of Management

1 INTRODUCTION

1.1 UNIT OF MANAGEMENT 01

The North Western - Neagh Bann (NWNB) CFRAM Study incorporates two River Basin Districts (RBDs), both of which are transboundary and are therefore classified as International River Basin Districts (IRBDs).

The North Western IRBD covers an area of 12,320 km² with approximately 7,400 km² of that area in Ireland. It includes two Units of Management (UoMs); UoM 01 (Donegal) and UoM36 (Erne). UoM01 includes hydrometric areas 01, 37, 38, 39 and 40. It covers an area of 4,610 km² within Ireland. This report covers only the portion of the Neagh Western UoM01 district within Ireland which includes the majority of County Donegal.

The principal Irish river system in UoM01 is the Foyle River (which flows northwards from the confluence of the rivers Finn and Mourne at Lifford and Strabane towns).

The Foyle forms the international border between Ireland and Northern Ireland, draining the Finn, Mourne and Deele sub-catchment, discharging into Lough Foyle.

In addition to the Foyle River system, there are numerous rivers and streams discharging to the estuaries and coastal waters all around the Donegal coastline including the Leannan, Owenea and Owencarrow rivers.

UoM01 is predominantly rural with the largest urban areas being Letterkenny, Donegal Town, Ballybofey & Stranorlar and Buncrana. Smaller towns and villages include Lifford, Moville and Dungloe.

The lower lying fertile soils of UoM01 are capable of supporting intensive agriculture. However, much of UoM01 is mountainous with coniferous forest plantations and some sheep and cattle grazing. The spectacular coastline, the surfing beaches and the remote beauty spots attract many tourists.

Within UoM01 the OPW has implemented and undertakes an annual programme to maintain the following Arterial Drainage Schemes: Deele, Swillyburn, Foyle Embankment, Abbey, Blanket Nook Embankment, Cloonburn, Swilly Embankment, also Thorn, Big Isle and Oldtown/ Newmills (Extensions to Swilly Embankment Drainage Scheme) and Skeoge & Burnfoot. These Schemes were undertaken by the OPW under the 1945 Arterial Drainage Act. The OPW continues to have statutory responsibility for inspection and maintenance of the Schemes, which includes a number of channels and designated tributaries. The primary focus of arterial drainage schemes is not for flood relief but for the improvement of agricultural land. Whilst not intended as a flood alleviation scheme the arterial drainage works undoubtedly reduce fluvial flood risk in certain parts of UoM01.

Drainage Districts represent areas where the Local Authorities have responsibilities to maintain watercourse channels and therefore contribute to maintaining the existing regime. In relation to the four Drainage Districts located within UoM01, none are located directly on the key watercourses where fluvial and coastal flood risk is being investigated.

In order to confirm the Areas for Further Assessment (AFAs) within the UoM, a Flood Risk Review was completed by the Western CFRAM Study (as it had to be undertaken before the North Western – Neagh Bann CFRAM Study commenced), the final report is available via the project website: *NWNB Flood Risk Review (March 2012): (Site Assessment Reports/Site Maps/AFA Boundaries/ Extreme Flood Outlines)*.

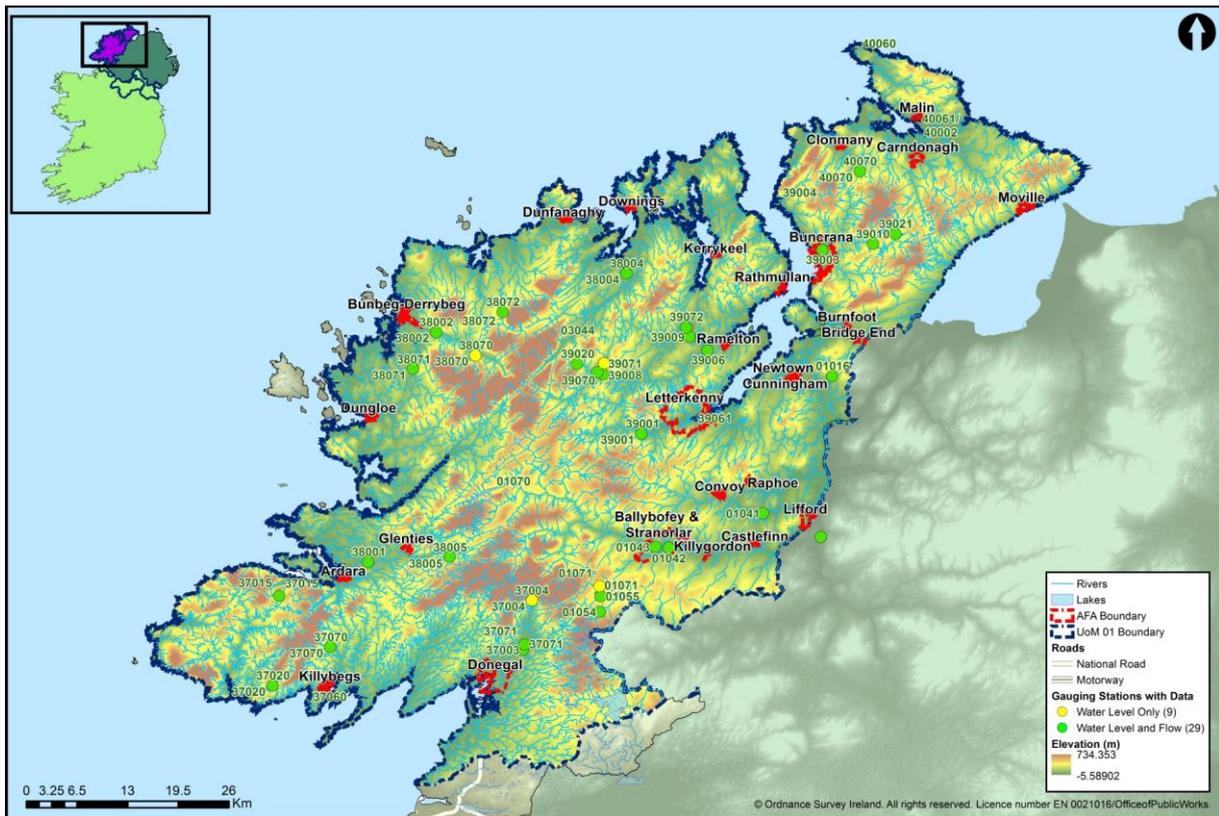


Figure 1.1: UoM01 Location Map

1.2 OBJECTIVE OF THIS REPORT

The principal objective of this report, in accordance with Section 12.2 of the CFRAM Studies Stage 1 Project Brief, is to; provide a summary of the relevant reports prepared for UoM01 as part of the North Western Neagh Bann CFRAM Study, and; detail the development of the draft UoM01 Flood Risk Management Plan (FRMP), which will be consulted on during the second half of 2016 and the finalisation of the UoM01 FRMP in preparation for its adoption in 2017.

This report also aims to identify any issues that may influence the proposed methodologies or programme going forward into the second cycle of Floods Directive implementation.

1.3 ACCOMPANYING AND SUPPORTING REPORTS

This report accompanies the UoM01 Flood Risk Management Plan containing the following volumes:

- VOLUME I Draft Flood Risk Management Plan
- VOLUME III SEA Environmental Report and Natura Impact Statement.

This final report is also supported by a suite of project deliverables, including flood maps and key UoM01 technical reports on inception, hydrology, hydraulics and preliminary options, which are summarised in Sections 2 to 5 of this report respectively. The development of the draft and final Flood Risk Management Plan (FRMP) is summarised in Section 6 of this report.

The full list of project reports to date, which also include a series of relevant consultation and environmental reports and specific assessments of flood risk, survey data and rainfall within the North Western Neagh Bann CFRAM Study area, are listed in Table 1.1.

Table 1.1: List of Reports – North Western Neagh Bann CFRAM Study Overall & UoM01 Specific Reports

Ref.	Document Title
Rp0001	IBE0700Rp0001_Communications Plan, Implementation Programmes & Event Plans <ul style="list-style-type: none"> • Initial Scoping Phase • Mapping Phase • Options Phase • Draft Plan Phase
Rp0002	IBE0700Rp0002_HA01 Inception Report
Rp0005	IBE0700Rp0005_Stakeholders Workshop No 1 Summary Report
Rp0006	IBE0700Rp0006_UoM01 Hydrology Report
Rp0007	IBE0700Rp0007_HA01, HA06 & HA36 North West Neagh Bann Survey Contract Report
Rp0011	IBE0700Rp0011_UoM01 Hydraulics Report
Rp0013	IBE0700Rp0013_NWNB SEA Constraints Report
Rp0014	IBE0700Rp0014_NWNB SEA Scoping Report
Rp0015	IBE0700Rp0015_NWNB AA Screening Report
Rp0016	IBE0700Rp0016_Mapping Phase Summary Report
Rp0017	IBE0700Rp0017_UoM01 POR
Rp0022	IBE0700Rp0022_E_SEA_Environmental_Report_D01 UoM01
Rp0024	IBE0700Rp0024_UoM01_NIS
Rp0026	N01_FRMP_PART01
Rp0030	IBE0700Rp0030_UoM01_draft final report
Rp0032	IBE0700Rp0032_Option Phase Summary Report
Rp0035	IBE0700Rp0035 UoM01 Strategic SUDS Report
Rp0038	IBE0700Rp0038_UoM01 Strategic Planning Report
Rp0039	IBE0700Rp0039_E_SEA_Environmental_Statement UoM01
Rp0044	IBE0700Rp0044_UoM01 Defence Asset Database Report

Ref.	Document Title
Rp0047	IBE0700Rp0047_ <i>NWNB CFRAM Study Preliminary Health & Safety Information</i>
Rp0049	N01_FRMP_PART01 Flood Risk Management Plan
Rp0053	IBE0700Rp0053_UoM01 final report (this report)
Rp0054	IBE0700Rp0054_Draft Plan Phase Synthesis Report
<i>OPW</i>	<i>UoM01 Consultation Synthesis report</i>

1.4 ACCOMPANYING AND SUPPORTING GIS DELIVERABLES

Table 1.2: North Western Neagh Bann CFRAM Study Overall & UoM36 Specific GIS Deliverables

Survey Data	Type	Scale	
Survey Water Channel	Polyline	UoM	
Surveys Cross Sections	Polyline	UoM	
Surveyed Structures	Polyline	UoM	
Floodplain Photo Location	Point	UoM	
Flood Model Datasets	Type	Scale	Scenario (Probability %AEP)
Extent	Polygon	AFA	Current (All)
			Mid-Range Future Scenario (All)
			High End Future Scenario (10, 1, 0.1)
Flood Zones	Polygon	AFA	Current (1, 0.1)
			Mid-Range Future Scenario (1, 0.1)
Depth	Raster	AFA	Current (All)
			Mid-Range Future Scenario (All)
			High End Future Scenario (10,1,0.1)
Velocity	Raster	AFA	Current (All)
Risk to Life	Raster	AFA	Current (10,1 0.1)
Defence Failure Scenario- Extent	Polygon	AFA	Current (2 Scenarios)
Defence Failure Scenario- Depth	Raster	AFA	Current (2 Scenarios)
Defence Failure Scenario-	Raster	AFA	Current (2 Scenarios)
Defence Failure Scenario-Risk to	Raster	AFA	Current (2 Scenarios)
Specific Risk (No. of Inhabitants)	Raster	AFA	Current (10, 1, 0.1)
			Mid-Range Future Scenario (10, 1, 0.1)
Specific Risk (Type of Economic Activity)	Point	UoM	Current (0.1)
			Mid-Range Future Scenario (0.1)
Specific Risk (Risk Density)	Raster	AFA	Current (0.1)
			Mid-Range Future Scenario (0.1)
Other Datasets			
Modelled River Centreline	Polyline	AFA	
Flows and Water Level Nodes	Point	AFA	Current, Mid-Range & High End
Defended Area	Polygon	AFA	Current (If Applicable)
			Mid-Range (If Applicable)
Def. Failure – Breach Time Steps	Polygon	AFA	
Def. Failure – Defence Removal	Polyline	AFA	
Def. Failure – Defence Removal	Point	AFA	
Defence Asset Database	Type	Scale	
UoM Asset Menu	Polyline	UoM	
UoM Asset Menu_Point	Point	UoM	
UoM Structure Menu	Polyline	UoM	
UoM Defence Asset Database	Geodatabase	UoM	
Geometry Infill (if Applicable)	CAD Dwg	AFA Specific	
Risk Management	Type	Scale	
Damage Assessment (Baseline)	Point	AFA	
Damage Assessment Benefit	Point	AFA	
Damage Assessment Defended	Point	AFA	

1.5 HEALTH & SAFETY ROLE

RPS have a role to advise the OPW on CFRAM Study related matters of Health and Safety; RPS undertook duties in the management of the Survey Contractor (ensuring compliance with best practice and Health, Safety and Welfare at Work legislation); and RPS was appointed as Project Supervisor Design Process (PSDP) under the Safety, Health and Welfare and Work (Construction Regulations) 2006 - updated 2013.

Within the remit of PSDP, RPS have undertaken a preliminary hazard management/risk assessment as part of the multi-criteria analysis of options. This has quantitatively assessed the potential hazards and risks associated with the construction and maintenance of options (for example Working near water (construction), Working near water (maintenance), Heavy plant and machinery, Working at heights (construction), Working at heights (maintenance), etc.). These have been collated into a North Western Neagh Bann CFRAM Study preliminary Safety File, has been reviewed by the PSDP and provided with the final project deliverables in 2017.

2 THE UoM01 INCEPTION REPORT

In 2012, an inception report was prepared for UoM01. Its principal objective was to provide detail on the relevant datasets identified for use in the Donegal Area as part of the North Western Neagh Bann CFRAM Study, and also provide an update on the collection and interpretation process at that stage for that data.

The inception report identified any issues that had been encountered in sourcing data and flagged any that were considered to potentially affect the proposed methodologies or programme going forward. The data requested, received or outstanding was detailed in the document, together with progress with data analysis, and in particular, the data collection and analysis undertaken with agencies in Northern Ireland in the context of this UoM being within an international River Basin District.

At the time of preparing the report RPS had not identified any significant data gaps that would impact on the completion of the North Western Neagh Bann CFRAM Study however this statement was made without having received any survey information or having full data returns for the information requested from the Local Authorities.

Key findings:

RPS had to adopt an ongoing data collection and quality assurance exercise, to incorporate additional or updated data, as the North Western Neagh Bann CFRAM Study evolved through its subsequent phases.

For example, when the LiDAR and cross sectional survey data were received and quality checked, it became evident that data correction was required during the hydraulic analysis stage. Similarly, population of the defence database remained “live” throughout the study, as, in some cases it was difficult to establish which structures were acting as formal or informal defences, and in others, the effectiveness of the defences required update of their condition due to damage by events or due to recent construction activities.

Thus, the flood risk management process must be considered as “live” as change can occur during the six year Floods Directive planning and implementation cycles. It is also not possible at any given point in time to categorically conclude that there are no data gaps which will impact in some way on the future stages of the North Western Neagh Bann CFRAM Study.

Throughout the North Western Neagh Bann CFRAM Study a register of datasets received was maintained, this is available with the project’s progress reporting for reference. Metadata provided with final project GIS deliverables is also available to confirm the versions of datasets utilised in the CFRAM Study analysis.

3 THE UoM01 HYDROLOGY REPORT

In 2013, RPS commenced the preparation of the UoM01 hydrology report. Its principal objectives were to build on the inception report methodology and to provide detail on the outputs from the processes of hydrological analysis and design flow estimation. The hydrology report did not include details of the data collection process, flood history within the Areas for Further Assessment (AFAs) or methodology and results from the historic flood analysis (except where this is used to inform the design flow estimation) as this was already contained within the Inception Report for UoM01.

The hydrology report provided a review and summary of the methodologies used as well as details of any amendments to the methodologies since completion of the Inception Report. The report detailed the results of the hydrological analysis and design flow estimation and summarised the outputs from the analysis which were taken forward as inputs to subsequent hydraulic modelling. Discussion was provided on the outputs in terms of the degree of confidence which can be attached to the outputs and the opportunities for providing greater certainty for future studies, including opportunities for improving the observed data used to inform the study.

The hydrological and hydraulic activities were interactive, whilst hydrological calibration can be achieved with regard to flow records a further stage of hydrology refinement is possible when the hydraulic outputs are considered, for example observations in relation to the accuracy of flooding outlines can necessitate refining the assumptions of timings of peaks for tributary watercourses rather than altering hydraulic model assumptions. Consequently, input from the mapping consultation programme was required before both the hydrological and hydraulic analysis could be concluded. Therefore, the hydrology report was finalised in 2016 after completion of the hydraulic modelling and in particular the rating reviews.

The UoM01 catchment can be characterised hydrologically as follows:

- The catchment has a wide range of climatic and physiographic characteristics. The drier, lowland areas in the Foyle floodplain have SAAR values as low as 1000mm while catchments in the upland areas of the Bluestack and Derryveagh Mountains have SAAR values in excess of 2000mm.
- Hydrometric data is of poor quality and availability.
- Meteorological data is of low availability in the catchment.
- Flood behaviour when defined in terms of the growth curve, i.e. in orders of magnitude greater than the median event, is relatively more extreme in the upper catchment than would have been thought based on older methodologies (FSR). This is in line with other more recent, catchment specific studies.

- The 1% AEP flood event ranges from approximately 1.7 to 2.8 times larger than the median flood flow. This compares to approximately 2 under FSR.

Key Findings:

The primary output of the hydrological analysis was design flow estimation which was based on historical data and estimation techniques. Hydrological analysis required further validation through the calibration of the hydraulic models which is reflective of best practice in hydrology/hydraulic modelling for flood risk assessment. RPS believe that the statistical analysis techniques used as the basis for the design flow estimation have as high a degree of certainty as is possible prior to calibration/validation and that the methodologies used yielded efficiency and increased accuracy in the hydraulic modelling phase of the CFRAM Study process. However, it should be noted that the interaction between the hydrology and hydraulic analysis and mapping meant that hydrology could not be finalised until mapping consultation was concluded.

Risks - The main potential source of uncertainty in the analysis is due to the lack of hydrometric gauge data in the majority of smaller catchments. Through the use of best practice statistical methods the design flow estimation had as high a degree of certainty as was possible prior to calibration/validation, nevertheless the modelling necessitated the adjustment of some of the design flows and as such any adjustments made were recorded within the NWNB CFRAM reporting. In addition, cross-border catchment areas and associated catchment descriptors within the existing FSU database were found not to represent the catchment entering from Northern Ireland such as the Skeoge catchment upstream of Bridge End, requiring catchment characteristics adjustment using relevant datasets. The lower reaches of the Finn were also found not to be represented accurately but this was mitigated for catchments which flow through Northern Ireland by using the Rivers Agency derived catchments which include catchment areas on both sides of the border.

After this cycle of the North Western Neagh Bann CFRAM Study the main potential adverse impact on the hydrological performance of the catchment is the effect of future changes including climate change and urbanisation. Sustainable development planning is key in mitigating this future risk, particularly consideration in the draft Flood Risk Management Plan of measures, such as, limiting post development run-off rates to greenfield rates (or lower) and the role of Sustainable Urban Drainage Systems.

Opportunities - the following potential opportunities to improve the hydrological analysis further in the next cycle of the North Western Neagh Bann CFRAM Study were identified:

1. *There are only six stations with flow data available located on the modelled reaches within UoM01 and of these stations only three were classified as having a good enough rating*

such that they were taken forward for use within the Flood Studies Update. If all the stations with flow data are considered which are on or directly upstream or downstream of the rivers to be modelled there are still 15 AFAs which can be considered ungauged. The uncertainty in the design flow estimates on such watercourses could be reduced by installing new gauging stations providing long term flow data records for small catchments. Furthermore there is a shortage nationally of very small and / or heavily urbanised catchment gauge data.

Recommendations were therefore provided within the draft plan to improve the availability of flood flow data. AFAs which are presently ungauged but are considered to have significant flood risk, and as such would significantly benefit from the installation of new gauge stations are identified as follows:

- *Ballybofey & Stranorlar (Burn Daurnett, Sessiagh and Magherapaste watercourses)*
- *Cardonagh (Donagh and Glengannon Rivers)*
- *Clonmany (Ballynahallan River)*
- *Donegal Town (River Eske)*
- *Downings (Magherabeg watercourse)*
- *Glenties (Stracashel River)*
- *Kerrykeel (Burnside River)*
- *Killybegs (Drumbeagh watercourse)*
- *Letterkenny (Glencar, Ballymacool / Sallaghagrane watercourses)*
- *Ramelton (Rathmelton River)*
- *Rathmullan (Ballyboe watercourse).*

There is also scope to improve the rating and record length of data at the existing gauge stations located on/upstream/downstream of AFAs where benefits can be achieved earlier and more cost effectively than would be the case through installing new gauging stations. This is particularly the case at Bunbeg-Derrybeg, Buncrana, Clonmany and Donegal Town where existing stations could potentially be upgraded to flood flow rated stations and the existing records utilised for the analysis of extreme floods. It is important also that the existing flood flow gauging stations are maintained such that their ratings are developed further and record lengths increased.

2. *The availability of high temporal resolution rainfall data may be used to supplement hydrometric data and may also be integral to the development of flood forecasting systems. Efforts should be made prior to the next cycle of the North Western Neagh Bann CFRAM Study to improve the availability of high resolution rainfall data within UoM 01. This may take the form of additional hourly rainfall gauges or may involve processing of radar data already available from the Castor Bay radar at Lough Neagh.*

- 3. There are 10 coastal AFAs for which the consideration of the joint occurrence of high river flows and extreme coastal water levels was necessary. The only long term tidal gauge data within UoM01 of sufficient length for extreme value analysis is at Malin Head which is so remote from any long term fluvial gauge locations that the applicability of the data for joint probability analysis is poor. In order to develop an improved understanding of the dependence between river flows and extreme coastal water levels in around the Donegal / UoM 01 coastline it is recommend that extended records are collected and made available for the next cycle of the CFRAM Study at the existing tidal gauges at Arranmore, Killybegs, Malin Head and Lisahally (NI).**
- 4. The delineation of cross-border catchments and derivation of associated FSU physical catchment descriptors should be reviewed to ensure potential errors in the data for catchments emanating from Northern Ireland is amended for future cycles.**

4 THE UoM01 HYDRAULICS REPORT

Following delivery of UoM01 survey data in 2013, RPS undertook development of hydraulic models and hazard mapping during 2013. Drafting of the hydraulic report in 2014, led to consultation on the draft final deliverables, including core hazard and risk mapping, (as specified under the Floods Directive), during 2015. The final hydraulics deliverables were completed during 2016, with reporting finalised in 2017.

UoM01 includes twenty six AFAs (one of which is Raphoe AFA at pluvial risk and studied separately). For the twenty five AFAs studies under the North Western Neagh Bann CFRAM Study, twenty one separate models were developed for flood risk analysis. A single model was developed for the Bridge End and Burnfoot AFAs, due to their proximity and hydraulic interaction, and, similarly for the Finn system (incorporating Ballybofey/Stranorlar, Castlefinn, Killygordon and Lifford AFAs).

The hydraulic analysis utilised computational modelling software informed by detailed topographical survey information (channel cross-sections, in-channel/flood defence structures, bathymetric and floodplain data), combined with hydrological inputs (riverine inflows and sea levels) and water-level control parameters (such as channel-roughness), to determine flood hazard.

The principal modelling software package used was the MIKE FLOOD software shell which was developed by the Danish Hydraulics Institute (DHI). This provided the integrated and detailed modelling required at a river basin scale and provides a 1-dimensional /2-dimensional interface for all detailed hydraulic model development thus enabling seamless integration of fluvial and coastal models in the AFAs for which this was required. MIKE FLOOD software was adopted for use in modelling twelve of the twenty five AFAs in UoM01 (eleven models were developed).

The ISIS hydraulic modelling software package (developed by CH2M HILL) was also used. ISIS 2D has a fully hydrodynamic computational engine designed to work alone or with ISIS 1D, enabling dynamic interaction between 1D and 2D models. Linking methods allow ISIS 1D and ISIS 2D to represent lateral floodplains, a 1D channel running into a 2D estuary, spill over defences, and other representations of river, coastal or floodplain systems. Multiple 2D domains, with different cell sizes, time steps and simulation times can be coupled to a single 1D model to represent different areas of floodplain at different resolutions. ISIS 2D software was used for nine AFAs in UoM01 (nine models were developed).

For the Finn system, an integrated catchment modelling approach was chosen using InfoWorks ICM. This software provides a single platform to incorporate both urban and river catchments using fully integrated 1D and 2D hydrodynamic simulation techniques. Tidal boundaries are applied to both 1D and 2D model domains to incorporate tidal inundation where appropriate. Infoworks ICM software was used for four AFA models in UoM01.

Key flood events, where available, were used in the calibration of each model whereby the model was reviewed in order to make sure historic flooding is accurately represented. The principal model parameters that were reviewed and amended during the model calibration process are:

- Bed and floodplain roughness coefficients;
- Structure roughness and head loss coefficients;
- Timing of hydrographs;
- Magnitude of hydrographs;
- Incorporation of additional survey information (e.g. additional cross-sections or missed structures).

The calibrated models (incorporating relevant updates following the consultation process) were used to simulate present day and future flood hazard conditions for events with a range of AEPs. There are inherent assumptions, limitations and uncertainty associated with hydraulic modelling, which are detailed for each hydraulic model within the hydraulics report. Defence failure scenarios (where required by the Contract – Letterkenny, Ballybofey and Lifford AFAs in UoM01) and sensitivity tests have been conducted for each model. The parameters selected for the sensitivity analysis were dependent on the specific model but generally included:

- Roughness coefficients;
- 2D domain grid cell size;
- Critical structure coefficients;
- Flow inputs;
- Operation of dynamic structures.

Key Findings:

A series of flood extent, depth, velocity, zone and risk-to-life maps known collectively as flood hazard maps were generated based on the model results.

The outputs from the hydraulic analysis inform the subsequent stages of the CFRAM Study - the models were used to simulate potential options, facilitating the appraisal of possible flood risk management actions and measures and model outputs also helped to determine and map the degree of flood risk.

The degree of confidence in the output of each model was also determined; this was heavily dependent on the availability of flow and flood records for specific areas, however available data has been used to the best extent possible throughout the study area.

The specific findings in relation to the hydraulic modelling of each of the AFAs within UoM01 in particular the 1%AEP fluvial (or 0.5%AEP coastal) design events are summarised as follows:

Ardara – Using the information available it was possible to compare certain areas that were identified to have flooded in the past and ascertain that the model is producing similar results. Overall there is moderate confidence in the both the hydrology and hydraulics of the Ardara AFA. Fluvial flooding is predicted at Ardara during a 1% AEP event. There are two locations which are affected and due to their close proximity they have potential to. Out of bank flooding is predicted on the Owentocker River due to insufficient channel capacity. Downstream of this, towards Ardara town, insufficient channel capacity is noted again, putting a small number of receptors at risk of flooding. There are a small number of residential properties and a business property at risk of flooding during a 1% AEP fluvial event. Therefore Ardara AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Ballybofey & Stranorlar - Overall there is good confidence in both the hydrology and hydraulics of the Ballybofey & Stranorlar AFA, particularly along the River Finn. Ballybofey & Stranorlar AFA is at risk of flooding during a 1% AEP fluvial event. The main flood risk is to receptors located along the River Finn. There are a number of locations along this watercourse where out of bank flooding is predicted which have the potential to influence one another. There are five further discrete locations of flooding within Ballybofey & Stranorlar AFA. These are mainly caused due to a single flood mechanism on tributaries of the main river. Receptors in these locations are also at risk during more frequent flood events. There are a number of residential properties and a business property at risk of flooding during a 1% AEP event. Several transport infrastructure assets including local roads and sections of the N15 are also located within the floodplains. A school which is a highly vulnerable property is included within the risk during a 1% AEP event. Due to the frequency of flooding at Ballybofey & Stranorlar there are significant event damages and risks in present day and future scenarios.

Bunbeg-Derrybeg - With the information available it was possible to compare certain areas that were identified to have flooded in the past and ascertain that the model is producing similar results. Bunbeg-Derrybeg is at risk of flooding during a 1% AEP fluvial event and a 0.5% AEP coastal event. There are a small number of locations where receptors are at risk. Out of bank flooding is predicted on the Cathleen River due to insufficient channel capacity. Immediately downstream of this, the channel capacity of the Cathleen River is again exceeded putting a receptor at risk. This receptor is also at risk during a 0.5% AEP coastal event due to the topography of the area. Further flooding is observed in a discrete location during the 1% AEP fluvial event on the Derrybeg River due to insufficient culvert capacity. A small number of properties, both residential and non-residential, are at risk of flooding within Bunbeg-Derrybeg AFA. A social infrastructure asset, Derrybeg Chapel, and a couple of transport infrastructure assets, a local and regional road, are also located within the floodplains. There are event damages and risks associated with Bunbeg-Derrybeg AFA in present day and future scenarios.

Buncrana - Despite the lack of calibration and verification data, the model is considered to be

performing satisfactorily for design event simulation. Buncrana AFA is subject to flooding during a 1% AEP fluvial event and a 0.5% AEP coastal event however the main flood risk is to receptors located along the Buncrana River. There are three discrete locations where fluvial flooding is predicted. On the Crana River, out of bank flooding is predicted due to insufficient channel capacity. On the Buncrana River flooding is due to insufficient channel capacity which results in overland flow and inundation of the floodplain. In a separate region properties are at risk of flooding from tidal inundation during a 0.5% AEP event. There are a number of residential and business properties at risk of flooding within Buncrana AFA. Social infrastructure assets including a leisure centre, social amenity sites and transport infrastructure assets including regional and urban local roads are situated within the floodplains. Crana River Water Treatment Plant is also at risk of flooding. There are substantial event damages and risks associated with Buncrana AFA in present day and future scenarios.

Burnfoot - Overall there is poor confidence in both the hydrology and hydraulics of the Burnfoot AFA with only a single historical event recorded. Burnfoot is subject to fluvial flooding during a 1% AEP event. All of the properties which are identified as at risk are within a discrete area located on the left bank of the Burnfoot River in the northern extent of the AFA. There are a number of residential properties at risk along with a couple of business properties. Due to the frequency of flooding Burnfoot AFA has damages and risks in present day and future scenarios.

Bridge End - Overall there is poor confidence in both the hydrology and hydraulics of the Bridge End due to limited recorded data. Fluvial flooding is predicted in Bridge End AFA during a 1% AEP event within one discrete area. It is located at the northern extent of the AFA and is predicted when water spills from the low left river embankment of Bridge End River, inundating the adjacent commercial area. A business property is affected during a 1% AEP fluvial event, but also floods during more frequent flood events. Bridge End AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Carndonagh - Confidence in the hydrological and hydraulic analysis for of the Carndonagh AFA is moderate. Carndonagh suffers from fluvial flooding during a 1% AEP event in multiple locations. The majority of the flooding originates from the Donagh River and its tributaries. There are a couple of regions with two locations of flooding which are considered as complex due to their potential for interaction. In one area, the Donagh River and the Ballywilly Brook contribute due to a combination of insufficient channel and culvert capacity. These watercourses combine resulting in backwater effects up the Ballywilly Brook. Immediately downstream of this a receptor is at risk due to low banks resulting in out of bank flooding. On the Carndonagh watercourse, flooding is predicted due to an extremely low left bank. Flooding is accentuated here due to the topography of the area and affects many properties. Downstream of this flooding is predicted again due to a low bank level. In a discrete area of

flooding, overland flow originating from the Glennagannon River is predicted due to insufficient channel capacity. A significant number of residential and business properties are at risk of flooding along with several transport infrastructure assets including regional and local roads. A community centre, which is a highly vulnerable property, is also situated within the floodplain. Due to the number of receptors affected there are event damages and risks associated with Carndonagh in present day and future scenarios.

Castlefinn - There is good confidence in both the hydrology and hydraulics of the Castlefinn AFA, particularly along the River Finn where there are long term gauging station records and good flood extent verification events. Castlefinn is subject to fluvial flooding during a 1% AEP event with the main flood risk originating from the River Finn and the Corcullion Tributary. Out of bank flooding is predicted from both watercourses although flooding on the tributary is largely due to elevated water levels in the River Finn flooding out along the tributary's lower reaches. The elevated water levels on the Finn are caused by a combination of flood flows emanating in the Finn catchment upstream of Castlefinn and a backwater effect coming from the Foyle/Mourne River system. A number of residential and non-residential properties are at risk during a 1% AEP event. Many transport infrastructure assets including a regional and a national road (N15) are also located within the floodplain. Castlefinn Waste Water Treatment Plant and a community centre which is classified as a highly vulnerable property are also at risk of fluvial flooding. These receptors are also affected during more frequent flooding events than the 1% AEP. Due to the frequency of flooding there are significant damages within Castlefinn AFA in present day and future scenarios.

Clonmany - Generally, historical evidence has provided an indication that this location is susceptible to flooding following heavy rainfall and subsequent overland flow with moderate confidence in both the hydrology and hydraulics of the Clonmany AFA. Clonmany is affected by fluvial flooding during a 1% AEP event in three discrete locations throughout the AFA. On the Ballynahallan River flooding is a consequence of insufficient channel capacity. Similarly on the Clonmany River the floodplain is inundated due to insufficient channel capacity. In a further location flooding from the Cleghagh Stream is predicted again due to insufficient channel capacity. A small number of residential properties and a couple of business properties are affected by flooding during a 1% AEP event in Clonmany. A community centre which is classified as a highly vulnerable property is at risk along with Clonmany Waste Water Treatment Works. Some of these receptors are also at risk during more frequent flood events. Clonmany AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Convoy - Due to the lack of quantitative data on previous flood events it has not been possible to calibrate the model with historical reports. Fluvial flooding is predicted in Convoy during a 1% AEP event in a small number of locations. On the Cloghroe River flooding is due to a

combination of insufficient capacity of a bridge and insufficient channel capacity upstream of this structure. Immediately downstream of this out of bank flooding is predicted as a consequence of insufficient channel capacity. In a separate discrete location flooding is predicted primarily because of insufficient channel capacity. However, water levels are high at this location during less frequent flood events due to the surcharging of a bridge, which also acts to reduce backwatering effects originating from downstream from the Cloghroe River. A small number of residential and non-residential properties and local roads are affected in each location. These receptors are also at risk of flooding during the less frequent events. Due to the frequency of flooding to receptors within Convoy there are damages in present day and future scenarios.

Donegal - There is moderate confidence in both the hydrology and hydraulics of the Donegal model as there was limited flood extent verification events and poor data recorded at the gauge stations in the area. Donegal is at risk from both 1% AEP fluvial events and 0.5% coastal events. Along the River Eske, the Drumrooske watercourse, the Drumlaght watercourse and the Drummenny River out of bank flooding which interacts is predicted. Another area of flooding is predicted due to the low lying land immediately downstream of Tyrconnell Bridge during a 0.5% tidal inundation event. A property in this region is also affected by fluvial flooding during a 1% AEP event. Three further discrete locations of flooding occur along the Drumgun watercourse, the Tully watercourse and the Tawnalary watercourse. These are a consequence of structures such as culverts which restrict flow during a flood event. There are a number of residential and business properties at risk of flooding within Donegal including social infrastructure assets such as a church and community centre, and cultural heritage assets. Environmental assets and transport infrastructure assets including national regional and local roads are also located within the floodplain. There are significant event damages and risks within Donegal AFA in present day and future scenarios.

Downings - Despite the limited calibration and verification data, data model is considered to be performing satisfactorily for design event simulation. Downings is at risk of flooding in two discrete locations during a 1% AEP fluvial and during a 0.5% AEP coastal event. Along the Magherbeg watercourse, out of bank flooding is predicted due to insufficient culvert capacity during a fluvial event. In a second area, a property is predicted to flood during a 0.5% AEP coastal event due to tidal inundation. There are a couple of local urban roads and residential and business properties at risk within Downings AFA including a sports and leisure centre, which is classified as a social infrastructure asset. These receptors are also at risk during more frequent flooding events. Due to the frequency of flooding within Downings AFA there are event damages and risks in present day and future scenarios.

Dunfanaghy - A report of recurring flooding from the OPW Area Engineer for Glenties was used to provide limited qualitative support for the model results. Dunfanaghy AFA is subject to

flooding during a 0.5% AEP coastal event and during a 0.5% wave overtopping event. The area at risk has multiple flood mechanisms affecting it. There are a reasonably large number of residential and business properties at risk within Dunfanaghy AFA including a community centre which is a social infrastructure asset. A small number of local roads and a national road (N56) are also at risk of flooding. Horn Head and Rinclevan SAC which is an environmental asset is also subject to flooding within this location. Due to the number of receptors at risk, there are significant event damages and risks within Dunfanaghy AFA.

Dungloe - The model gives satisfactory representation of flood mechanisms described from available flood event records and is considered to be performing satisfactorily for design event simulation. Fluvial 1% AEP events and coastal 0.5% AEP events cause flooding at two discrete locations within Dungloe AFA. Tidal inundation is predicted in the low lying area immediately east of Dungloe Pier during a 0.5% AEP event. Fluvial flooding is predicted on the Dungloe River due to raised water levels caused by a bridge on Main Street. Further flooding is predicted at the Atlantic Bar where the gable wall forms part of the river channel on the left hand bank. A residential and a non-residential property are affected within Dungloe during these flood events. Dungloe AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Glenties - There is good confidence in both the hydrology and hydraulics of the Glenties AFA due to the presence of a gauging station and flood extent verification events. Fluvial flooding is predicted during a 1% AEP event in a couple of locations within Glenties AFA. One of these is located in the east of the AFA along Stracashel River whilst the other is located along the Gortnamucklagh River. Flooding along the Gortnamucklagh is due to the effect of a road bridge. A small number of residential and business properties are at risk during a 1% AEP event. A social amenity site and environmental assets are also located within the floodplains. A number of these receptors are also at risk of flooding during more frequent flood events. Due to the frequency of flooding Glenties AFA has event damages and risks in present day and future scenarios.

Kerrykeel - There is moderate confidence in the hydrological and hydraulic analysis of the Kerrykeel AFA. Fluvial flooding is predicted within Kerrykeel during a 1% AEP event. Out of bank flooding is predicted from the Burnside River due to insufficient culvert capacity. This reduced capacity would cause water to back up and spill out of bank in two distinctive flow paths. The first of these is from the right bank which continues overland before re-joining the river. This is exacerbated by a high water level upstream of a road bridge. The second flow path is from the left bank where flow gathers around a low area at the northern end of the sports pitch. A number of residential properties and a business property are at risk of flooding during a 1% AEP event. A regional road and a sports pitch, which is a social amenity, are also located within the floodplain in Kerrykeel. Due to the number of properties affected there are

significant event damages and risks in present day and future scenarios.

Killybegs - Overall there is moderate confidence in both the hydrology and hydraulics of the model. Killybegs is at risk during 1% AEP fluvial events, 0.5% AEP coastal events and 0.5% AEP wave overtopping events. The majority of Killybegs AFA's flood risk is in one area along the Drumbeagh watercourse. Properties are affected during both 1% AEP fluvial and 0.5% AEP coastal events. There are five further discrete locations of flooding which are all affected by coastal flooding mechanisms. Receptors in these locations are affected due to the low lying topography of the land, making them susceptible to tidal inundation. There are a number of residential and non-residential properties at risk within Killybegs including a health centre which is a social infrastructure asset. A couple of local roads and social amenity sites are also located within the floodplains. A number of these receptors are also at risk during less frequent flooding events. Due to the frequency and number of properties which are at risk within Killybegs, there are significant event damages and risks in present day and future scenarios.

Killygordon - Overall, there is good data in relation the River Finn flows and in relation to the flood extents on the River Finn however no significant verification information in relation to the smaller watercourses exists for the Killygordon AFA with which to verify the model hydrology and hydraulics. Fluvial flooding is predicted in Killygordon during a 1% AEP event, although no properties within the AFA are at risk of flooding. However, a national primary road (N15) is located within the floodplain along with an environmental asset, River Finn SAC. Killygordon AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Letterkenny - There is good confidence in both the hydrology and hydraulics of the Letterkenny AFA. Letterkenny is subject to flooding during a 1% AEP fluvial event and a 0.5% AEP coastal event. There are a number of locations which have multiple flood mechanisms. A small number of locations in close proximity flood due to high water levels in the River Swilly. These locations are also affected by tidal mechanisms although fluvial flooding is dominant. Another small number of locations which are in close proximity flood mainly due to high water levels in the River Swilly backing up into the tributaries. These locations are both fluvially and tidally influenced with tidal mechanisms being dominant. There are four further discrete locations of flooding within Letterkenny AFA, all fluvially influenced. Flooding in these locations is due to a combination of restricted flow in culverts and in bridges. There are a number of both residential and business properties at risk of flooding within Letterkenny AFA. Several social amenity sites and transport infrastructure assets including national, regional and local roads are also located within the floodplains. Due to the number of properties at risk there are significant event damages and risks associated with Letterkenny AFA in present day and future scenarios.

Lifford - There is good confidence in both the hydrology and hydraulics of the Lifford AFA given that all of the rivers have gauging stations upstream of Lifford and good flood extent verification events. Lifford AFA is subject to flooding during a 1% AEP fluvial event. The main flood risk is due to out of bank flooding from along the left bank of the Finn and Foyle Rivers and from the right bank of the Dee River. All three rivers in the vicinity of the AFA are tidally influenced but fluvial flooding is the dominant mechanism in relation to all receptors. A significant number of residential and non-residential properties are at risk in Lifford AFA including social infrastructure assets such as a local authority office and a post office. Lifford Waste Water Treatment Plant and a number of transport infrastructure assets including a national road are also located in the floodplain. Due to the number of receptors at risk, there are substantial event damages and risks associated with Lifford AFA in present day and future scenarios.

Malin - Limited qualitative support for the model results has been achieved based on the data available, however due to the lack of data the accuracy of this model is somewhat unknown. Malin suffers from coastal flooding during a 0.5% AEP event in one local area. Tidal inundation would occur in Malin on both sides of Malin Bridge during a 0.5% AEP event putting a small number of properties at risk. A small number of business properties along with a residential property are at risk of flooding in Malin AFA. A regional road and environmental assets including the North Inishowen Coast SAC and Trawbreaga Bay SPA are also at risk during the 0.5% AEP coastal event. Malin AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Moville - With the limited information available it was possible to compare certain areas that were identified to have flooded in the past and ascertain that the model is producing similar results. Receptors in Moville are affected by flooding during a 1% AEP fluvial event, a 0.5% AEP coastal event and also during a 0.5% AEP wave overtopping event. One area is affected by both coastal mechanisms due to the low lying topography of the land. Properties along River Row and along the coast between Bredagh Glen watercourse and the pier at the end of Quay Street are at risk of flooding. On the eastern extent of the AFA, out of bank flooding is predicted due to restricted culvert capacity which causes water to spill onto Main Street. There are a number of residential properties and a business property affected by flooding within Moville AFA. A small number of local roads and a social amenity site are also at risk. Due to the number of properties affected by flooding within Moville AFA there are significant event damages and risks in present day and future scenarios.

Newton Cunningham - Overall there is poor confidence in both the hydrology and hydraulics of Newtown Cunningham AFA due to the lack of gauging stations and flood extent verification events. Newton Cunningham AFA is affected by both 1% AEP fluvial events and 0.5% coastal inundation events. However, as no properties or other receptors are at risk of flooding within the

AFA it is considered to be at very low risk during the present day 1% AEP fluvial event.

Ramelton - A limited verification exercise has been undertaken based on the data available, however due to the lack of data the accuracy of this model is somewhat unknown. It should be noted that, for the purposes of the optioneering process, the risk in Ramelton AFA was evaluated due to a known high risk of culvert blockage. Ramelton suffers from flooding during a 1% AEP fluvial event and during a 0.5% AEP coastal event; however the main risk originates from tidal inundation. Coastal flooding is predicted on the left bank of the Leannan River upstream of Ramelton Bridge. Out of bank flooding also is predicted in this area during a 1% AEP fluvial event from the left bank of the Leannan River, adjacent to the weir. Downstream of this tidal inundation is predicted on the right bank of Leannan River as water levels rise above the level of the current quay walls. Due to the close proximity of these locations they have potential to interact. There is also a discrete area of flooding affected during a 1% AEP fluvial event, which can be caused due to a 66% blockage of total flow through a bridge. If this occurs flow would be restricted upstream of this resulting in water levels rising beyond the top of the right bank. There are a number of both residential and non-residential properties at risk of flooding within Ramelton, including social infrastructure assets such as a health centre and a community centre. Several local roads are also located within the floodplains. Many of these receptors are also at risk of flooding during more frequent events. Due to the frequency of flooding of properties, there are significant event damages and risk associated with Ramelton AFA in present day and future scenarios.

Rathmullan - There is moderate confidence in both the hydrology and hydraulics as there is limited historical flood data for specific events and as there are no active gauging stations within the model extent, consequently model calibration was not possible. Rathmullan is affected in a small number of locations throughout the AFA during a 1% AEP fluvial event, a 0.5% AEP coastal event and during a 0.5% AEP wave overtopping event. At the south east of the AFA, a number of properties are affected by both coastal flooding mechanisms. There are a further two discrete locations of flooding where receptors are at risk from fluvial flooding. An overland flow path originating from the Ballyboe River is caused due to a long culvert with restricted capacity, whilst flooding also is predicted from the right bank of Millbrook Stream. There are a number of residential properties at risk of flooding within Rathmullan AFA. Several local roads and a regional road are also at risk along with an environmental asset, Lough Swilly SAC & SPA. Many of these receptors are also at risk of flooding during more frequent events. Due to the frequency of flooding of receptors, there are significant event damages and risks associated with Rathmullan AFA in present day and future scenarios.

5 THE UoM01 PRELIMINARY OPTIONS REPORT

In early 2015 a series of Public Consultation Days were held regarding the draft core flood hazard and risk mapping deliverables. After completion of this, project level, consultation, RPS commenced detailed risk assessment and optioneering. In April 2015, Engineers from the Flood Risk Assessment and Management (FRAM) Section in OPW attended a two day workshop in RPS offices in order to review the outcome of the mapping public consultation on the flood mapping, discuss the detail of the next stages of analysis, confirm the scope of optioneering (in certain areas with previous schemes) and resolve any associated queries.

Risk assessment (including economic analysis) and preliminary optioneering was completed in draft for all AFAs within UoM01 by January 2016, and a series of Progress Group workshops were held (in November and December 2015 and February 2016) to review the outputs and obtain comments from the Progress Group members. A further OPW/RPS workshop was held in December 2015 dealing with reporting feedback and final technical inputs (for example climate change analysis). The initial feedback from the workshops was addressed and a series of project level public consultation days on the preliminary options were held in early 2016 and the preliminary options report (PORs) was completed in mid-2016, in parallel with the draft Flood Risk Management Plan which drew heavily on the POR's findings. It is worth noting that at Preliminary Options Report stage the options are developed to line and level with a significant amount of work required before they can be progressed to construction stage.

The Preliminary Options Report (POR) was accompanied by AFA specific appendices containing supporting technical details on all potential options (whole life costing, multi-criteria analysis and option drawings) and also supporting information such as method screening calculations, GIS layers supporting the risk and options analysis and health and safety information. Some elements of analysis were de-coupled and reported separately in 2016/2017, namely a strategic Sustainable Urban Drainage Systems (SUDS) analysis and a review of Spatial Planning and Impacts of Development.

All AFAs within UoM01 were screened and an optioneering assessment was undertaken at POR stage. Within the draft plans some Areas of Further assessment (AFAs) were found to have low predicted levels of risk to properties. The Preliminary Options Reports contain detail of minor localised works for some of these low-risk AFAs that were not considered significant enough for inclusion in the draft FRMP, but that may be examined further and developed through, for example, the Minor Works programme. It should be noted that a low level of predicted risk to existing property does not equate to there being no predicted flooding in an AFA, and the requirements of the Planning System and Flood Risk Management Guidelines should still be applied to ensure future development takes account of the predicted flood hazard present.

A very low risk was identified in Ardara, Bridge End, Clonmany, Dungloe, Killygordon, Malin and Newtown Cunningham AFAs. For these AFAs, Public Consultation Days were not held at the Options development stage and ultimately AFA-specific measures were not included in the draft FRMP;

however, the Unit of management-scale measures are still applicable, as well as a recommendation to maintain the existing regime.

Whilst the project level consultation on the mapping was undertaken in the first quarter of 2015, the formal SI consultation was delayed by an update of the relevant legislation and was not completed until the fourth quarter of 2015. This meant that the optioneering had been progressed without having closed out the observations and objections on the mapping, introducing the possibility that model updates may have been required after optioneering has been undertaken. This risk was constrained by the relatively low number of observations received which related to providing flooding information relevant to Castlefinn, Ballybofey/Stranorlar, Donegal and Ramelton AFAs which were considered during the optioneering process.

The OPW awarded a specialist contract to develop an analysis tool to support the whole-life costing of the CFRAM Study options, so that these were consistently applied at national level, in order that the resulting options would be comparable for use to develop a nationally prioritised programme of implementation. Local Authority and the OPW regional team feedback raised concerns regarding the outcome costs of some options developed under this tool, particularly with regard to smaller schemes, and a wider perception that coastal works costing may be generally conservative, whilst culverting works may be less so. Although the database was informed by costs for completed projects, RPS considered it prudent to respond to these concerns by lowering the benefit cost ratio threshold for potential schemes. A cut-off ratio of 0.5 (rather than 1.0) was used so that more potentially viable schemes were retained in the optioneering process. The following explanatory note was included in the draft FRMP *“option(s) identified has(have) a BCR below unity. It is considered that the costs for certain works, or smaller schemes, is likely to be conservative in the Unit Cost Database. More detailed assessment of costs, taking local factors into consideration, may improve the BCR”*. This was further identified within the final plan in relation to Burnfoot, which required further investigation of potentially viable flood relief works. These works may be implemented after project-level assessment and planning or exhibition and confirmation.

The risk assessment, and particularly the economics aspects, drew together and analysed a range of datasets. For consistency, the same base year and versions of data (including Middlesex Flood Hazard Research Centre damage statistics) were utilised across the CFRAM studies. During the analysis it was noted that there were gaps and inconsistencies between the An Post geodatabase and the OSi buildings layers which required significant truthing and update. In addition datasets on basements were difficult to obtain, and these could not always be seen from external inspection, with many of these identified only during the Progress Group review process, resulting in reworking of damages and options in some cases.

Recognising the benefit of the draft mapping Progress Group workshops, RPS again found the addition of workshops with the OPW, on methodology/process, and the progress group, to gain local knowledge, to be useful, and a subsequent workshop on identification of the proposed option for each AFA was held with the OPW during the preparation of the draft FRMP. This engagement process, at

least in part, meant that there was less change between the potential options presented in the POR and those ultimately presented in the draft FRMP than might have been expected. The consultation on the options mainly informed stakeholders and the wider public, whilst a great deal of local knowledge was provided, there was little feedback received in terms of alternatives or modifications that resulted in alteration of the options in the draft FRMP.

Key Findings:

Local Authority and the OPW regional team feedback regarding the unit cost database analysis tool raised concerns regarding conservative outcome costs of some options developed under this tool, particularly with regard to smaller schemes, and coastal works, whilst culverting works may be less conservative. Although the database was informed by costs for completed projects, it was considered prudent to respond to these concerns by lowering the benefit cost ratio threshold for potential schemes. A cut-off ratio of 0.5 (rather than 1.0) was used so that more potentially viable schemes were retained in the optioneering process. The following explanatory note was included in the draft FRMP “option(s) identified has(have) a BCR below unity. It is considered that the costs for certain works, or smaller schemes, is likely to be conservative in the Unit Cost Database. More detailed assessment of costs, taking local factors into consideration, may improve the BCR”.

During the economic analysis it was noted that there were some dataset gaps and inconsistencies, for example between the An Post geodatabase and the OSi buildings layers which required significant truthing and update. In addition datasets on basements were difficult to obtain, and these could not always be seen from external inspection, with many of these identified only during the Progress Group review process, resulting in reworking of damages and options in some cases.

The main deliverables for of the Preliminary Options Report were the AFA specific risk analysis and the assessment of a series of potential flood risk management measures relevant at differing spatial scales of assessment (UoM, Sub-Catchment and AFA). These are presented in the following Tables 5.1 and 5.2 for the risk assessment and potential options for UoM01 respectively.

Table 5.1 Flood Risk Analysis UoM01**(Fluvial statistics unless otherwise stated; Coastal = Coastal / Tidal Flooding; Coastal 2 = Wave Overtopping Flooding)**

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event								
	Ardara AFA	Ballybofey & Stranorlar AFA	Bridge End AFA	Bunbeg-Derrybeg AFA	Buncrana AFA	Burnfoot AFA	Carndonagh AFA	Castlefinn AFA	Clonmany AFA
Current Scenario (Present Day)									
Event Damage (€)	385,395	5,767,931	345,210	1,235,561 Fluvial 147,893 Coastal	23,727,431 Fluvial 832,958 Coastal	1,211,135	6,386,854	5,798,929	442,173
Residential Properties	15	53	0	1 Fluvial 1 Coastal	21 Fluvial 6 Coastal	20	32	18	7
Business Properties	1	6	1	2 Fluvial 0 Coastal	2 Fluvial 3 Coastal	2	10	17	2
Utilities	1	0	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0	0	1	1
Major Transport Assets	3	17	5	4 Fluvial 3 Coastal	12 Fluvial 2 Coastal	3	5	10	1
Highly Vulnerable Properties	0	2	0	1 Fluvial 0 Coastal	1 Fluvial 1 Coastal	0	0	1	0
Social Infrastructure Assets	0	13	0	0 Fluvial 0 Coastal	29 Fluvial 28 Coastal	0	1	0	0
Environmental Assets	2	2	1	2 Fluvial 0 Coastal	3 Fluvial 3 Coastal	2	2	2	1
Potential Pollution Sources	0	0	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0	0	0	0

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event								
	Ardara AFA	Ballybofey & Stranorlar AFA	Bridge End AFA	Bunbeg-Derrybeg AFA	Buncrana AFA	Burnfoot AFA	Carndonagh AFA	Castlefinn AFA	Clonmany AFA
Mid-Range Future Scenario									
Event Damage (€)	2,401,191	43,194,694	1,925,242	1,804,476 Fluvial 264,256 Coastal	41,877,633 Fluvial 1,916,662 Coastal	1,915,534	7,051,286	9,197,729	1,056,356
Residential Properties	22	88	4	1 Fluvial 1 Coastal	34 Fluvial 8 Coastal	26	35	23	21
Business Properties	5	51	14	2 Fluvial 1 Coastal	6 Fluvial 3 Coastal	4	12	25	3
Utilities	1	0	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0	0	1	1
Major Transport Assets	6	32	6	4 Fluvial 3 Coastal	18 Fluvial 6 Coastal	5	5	11	1
Highly Vulnerable Properties	0	3	0	0 Fluvial 0 Coastal	1 Fluvial 0 Coastal	0	0	1	0
Social Infrastructure Assets	0	13	0	1 Fluvial 1 Coastal	29 Fluvial 28 Coastal	0	3	0	0
Environmental Assets	2	2	1	4 Fluvial 4 Coastal	3 Fluvial 3 Coastal	2	8	2	1
Potential Pollution Sources	0	0	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0	0	0	0

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event								
	Ardara AFA	Ballybofey & Stranorlar AFA	Bridge End AFA	Bunbeg-Derrybeg AFA	Buncrana AFA	Burnfoot AFA	Carndonagh AFA	Castlefinn AFA	Clonmany AFA
High-End Future Scenario									
Event Damage (€)	14,121,618	81,362,869	5,217,864	2,153,717 Fluvial 838,308 Coastal	50,575,966 Fluvial 4,843,100 Coastal	3,044,627	9,719,230	12,843,342	1,766,891
Residential Properties	34	127	8	1 Fluvial 1 Coastal	112 Fluvial 23 Coastal	29	44	32	26
Business Properties	19	77	22	3 Fluvial 2 Coastal	9 Fluvial 5 Coastal	6	14	26	4
Utilities	1	0	1	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	1	0	1	1
Major Transport Assets	6	39	7	4 Fluvial 3 Coastal	22 Fluvial 13 Coastal	5	5	13	4
Highly Vulnerable Properties	1	6	0	0 Fluvial 0 Coastal	1 Fluvial 0 Coastal	0	0	1	0
Social Infrastructure Assets	0	13	0	1 Fluvial 1 Coastal	30 Fluvial 29 Coastal	0	3	0	0
Environmental Assets	2	2	1	4 Fluvial 4 Coastal	3 Fluvial 3 Coastal	2	8	2	1
Potential Pollution Sources	0	0	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0	0	0	0

Table 5.1 Flood Risk Analysis UoM01 continued

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event								
	Convoy AFA	Donegal AFA	Downings AFA	Dunfanaghy AFA	Dungloe AFA	Glenties AFA	Kerrykeel AFA	Killybegs AFA	Killygordon AFA
Current Scenario (Present Day)									
Event Damage (€)	9,898,818	11,129,699 Fluvial 2,545,103 Coastal	332,654 Fluvial 11,383 Coastal	4,516,097 Coastal 1,131,552 Coastal 2	80,644 Fluvial 42,164 Coastal	3,767,202	491,470	2,006,000 Fluvial 5,052,210 Coastal 4,535,768 Coastal 2	0
Residential Properties	5	35 Fluvial 3 Coastal	2 Fluvial 1 Coastal	13 Coastal 10 Coastal 2	0 Fluvial 1 Coastal	4	12	13 Fluvial 16 Coastal 0 Coastal 2	0
Business Properties	4	27 Fluvial 11 Coastal	1 Fluvial 0 Coastal	24 Coastal 7 Coastal 2	1 Fluvial 0 Coastal	4	1	11 Fluvial 24 Coastal 5 Coastal 2	0
Utilities	0	0 Fluvial 1 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal2	0
Major Transport Assets	4	25 Fluvial 6 Coastal	5 Fluvial 3 Coastal	5 Coastal 0 Coastal 2	1 Fluvial 3 Coastal	1	3	1 Fluvial 3 Coastal 0 Coastal 2	0
Highly Vulnerable Properties	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal 2	0
Social Infrastructure Assets	2	5 Fluvial 4 Coastal	0 Fluvial 0 Coastal	1 Coastal 1 Coastal 2	0 Fluvial 0 Coastal	1	0	3 Fluvial 3 Coastal 1 Coastal 2	0
Environmental Assets	1	6 Fluvial 6 Coastal	4 Fluvial 4 Coastal	2 Coastal 2 Coastal 2	1 Fluvial 1 Coastal	2	2	1 Fluvial 3 Coastal 1 Coastal 2	3
Potential Pollution Sources	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal 2	0

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event								
	Convoy AFA	Donegal AFA	Downings AFA	Dunfanaghy AFA	Dungloe AFA	Glenties AFA	Kerrykeel AFA	Killybegs AFA	Killygordon AFA
Mid-Range Future Scenario									
Event Damage (€)	13,334,332	22,261,356 Fluvial 12,919,316 Coastal	579,595 Fluvial 394,193 Coastal	10,333,507 Coastal 9,642,182 Coastal 2	174,824 Fluvial 170,319 Coastal	5,388,019	710,393	2,289,779 Fluvial 12,808,383 Coastal 33,459,391 Coastal2	38,478
Residential Properties	8	58 Fluvial 30 Coastal	19 Fluvial 2 Coastal	15 Coastal 15 Coastal 2	2 Fluvial 2 Coastal	12	14	13 Fluvial 21 Coastal 10 Coastal2	0
Business Properties	4	44 Fluvial 34 Coastal	2 Fluvial 2 Coastal	25 Coastal 25 Coastal 2	2 Fluvial 0 Coastal	11	1	13 Fluvial 34 Coastal 35 Coastal 2	1
Utilities	0	1 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal 2	0
Major Transport Assets	5	42 Fluvial 25 Coastal	10 Fluvial 8 Coastal	7 Coastal 4 Coastal 2	3 Fluvial 5 Coastal	1	6	1 Fluvial 5 Coastal 6 Coastal 2	0
Highly Vulnerable Properties	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal 2	0
Social Infrastructure Assets	2	8 Fluvial 6 Coastal	0 Fluvial 0 Coastal	1 Coastal 1 Coastal 2	0 Fluvial 0 Coastal	1	0	3 Fluvial 8 Coastal 7 Coastal 2	0
Environmental Assets	1	6 Fluvial 6 Coastal	4 Fluvial 4 Coastal	2 Coastal 2 Coastal 2	1 Fluvial 1 Coastal	2	2	1 Fluvial 3 Coastal 1 Coastal2	3
Potential Pollution Sources	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal 2	0

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event								
	Convoy AFA	Donegal AFA	Downings AFA	Dunfanaghy AFA	Dungloe AFA	Glenties AFA	Kerrykeel AFA	Killybegs AFA	Killygordon AFA
High-End Future Scenario									
Event Damage (€)	15,632,102	45,430,152 Fluvial 30,042,174 Coastal	1,159,068 Fluvial 5,939,185 Coastal	18,987,561 Coastal 15,206,843 Coastal 2	258,677 Fluvial 342,687 Coastal	8,344,453	1,063,935	2,710,696 Fluvial 21,512,078 Coastal 41,879,221 Coastal 2	68,468
Residential Properties	21	95 Fluvial 38 Coastal	21 Fluvial 22 Coastal	24 Coastal 15 Coastal 2	1 Fluvial 4 Coastal	14	17	14 Fluvial 19 Coastal 11 Coastal 2	1
Business Properties	7	70 Fluvial 48 Coastal	7 Fluvial 11 Coastal	35 Coastal 26 Coastal 2	2 Fluvial 0 Coastal	18	4	16 Fluvial 46 Coastal 40 Coastal 2	1
Utilities	0	1 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	1	0	0 Fluvial 0 Coastal 0 Coastal 2	0
Major Transport Assets	5	47 Fluvial 27 Coastal	10 Fluvial 8 Coastal	9 Coastal 4 Coastal 2	3 Fluvial 8 Coastal	2	7	1 Fluvial 7 Coastal 8 Coastal 2	0
Highly Vulnerable Properties	0	0 Fluvial 0 Coastal	0 Fluvial 1 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	1	1 Fluvial 0 Coastal 0 Coastal 2	0
Social Infrastructure Assets	2	10 Fluvial 9 Coastal	0 Fluvial 0 Coastal	3 Coastal 1 Coastal 2	0 Fluvial 0 Coastal	1	0	5 Fluvial 9 Coastal 8 Coastal 2	0
Environmental Assets	1	6 Fluvial 6 Coastal	4 Fluvial 4 Coastal	2 Coastal 2 Coastal 2	1 Fluvial 1 Coastal	2	2	1 Fluvial 3 Coastal 2 Coastal 2	3
Potential Pollution Sources	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0	0	0 Fluvial 0 Coastal 0 Coastal 2	0

Table 5.1 Flood Risk Analysis UoM01 continued

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event						
	Letterkenny AFA	Lifford AFA	Malin AFA	Moville AFA	Newtown Cunningham AFA	Ramelton AFA	Rathmullan AFA
Current Scenario (Present Day)							
Event Damage (€)	60,579,244 Fluvial 14,057,330 Coastal	17,293,243	0 Fluvial 492,505 Coastal	146,296 Fluvial 362,256 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	1,225,111 Fluvial 1,922,790 Coastal	847,451 Fluvial 126,378 Coastal 695,153 Coastal 2
Residential Properties	11 Fluvial 4 Coastal	41	0 Fluvial 1 Coastal	1 Fluvial 17 Coastal 8 Coastal 2	0 Fluvial 0 Coastal	10 Fluvial 14 Coastal	8 Fluvial 8 Coastal 13 Coastal 2
Business Properties	21 Fluvial 15 Coastal	37	0 Fluvial 4 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	2 Fluvial 11 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Utilities	0 Fluvial 0 Coastal	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Major Transport Assets	16 Fluvial 8 Coastal	7	1 Fluvial 2 Coastal	2 Fluvial 1 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	1 Fluvial 0 Coastal	3 fluvial 1 Coastal 3 Coastal 2
Highly Vulnerable Properties	0 Fluvial 0 Coastal	1	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Social Infrastructure Assets	28 Fluvial 21 Coastal	7	0 Fluvial 0 Coastal	5 Fluvial 4 Coastal 0 Coastal 2	1 Fluvial 0 Coastal	1 Fluvial 3 Coastal	0 Fluvial 1 Coastal 0 Coastal 2
Environmental Assets	7 Fluvial 7 Coastal	3	0 Fluvial 3 Coastal	1 Fluvial 1 Coastal 0 Coastal 2	2 Fluvial 2 Coastal	4 Fluvial 4 Coastal	3 Fluvial 4 Coastal 3 Coastal 2
Potential Pollution Sources	0 Fluvial 0 Coastal	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event						
	Letterkenny AFA	Lifford AFA	Malin AFA	Moville AFA	Newtown Cunningham AFA	Ramelton AFA	Rathmullan AFA
Mid-Range Future Scenario							
Event Damage (€)	96,837,264 Fluvial 51,428,071 Coastal	27,810,006	6,628 Fluvial 1,433,247 Coastal	718,818 Fluvial 1,935,362 Coastal 2,542,565 Coastal 2	0 Fluvial 0 Coastal	2,712,205 Fluvial 5,119,593 Coastal	855,017 Fluvial 894,226 Coastal 695,153 Coastal 2
Residential Properties	62 Fluvial 16 Coastal	59	1 Fluvial 4 Coastal	15 Fluvial 17 Coastal 18 Coastal 2	0 Fluvial 0 Coastal	17 Fluvial 16 Coastal	7 Fluvial 17 Coastal 13 Coastal 2
Business Properties	54 Fluvial 59 Coastal	50	0 Fluvial 8 Coastal	0 Fluvial 3 Coastal 3 Coastal 2	0 Fluvial 0 Coastal	9 Fluvial 16 Coastal	0 Fluvial 2 Coastal 0 Coastal 2
Utilities	0 Fluvial 0 Coastal	1	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Major Transport Assets	32 Fluvial 19 Coastal	8	2 Fluvial 7 Coastal	3 Fluvial 4 Coastal 3 Coastal 2	0 Fluvial 0 Coastal	5 Fluvial 5 Coastal	3 Fluvial 7 Coastal 3 Coastal 2
Highly Vulnerable Properties	0 Fluvial 0 Coastal	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Social Infrastructure Assets	42 Fluvial 31 Coastal	8	0 Fluvial 0 Coastal	5 Fluvial 4 Coastal 2 Coastal 2	1 Fluvial 0 Coastal	1 Fluvial 3 Coastal	0 Fluvial 2 Coastal 0 Coastal 2
Environmental Assets	7 Fluvial 7 Coastal	3	0 Fluvial 3 Coastal	2 Fluvial 2 Coastal 1 Coastal 2	2 Fluvial 2 Coastal	4 Fluvial 4 Coastal	3 Fluvial 4 Coastal 3 Coastal 2
Potential Pollution Sources	0 Fluvial 0 Coastal	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event						
	Letterkenny AFA	Lifford AFA	Malin AFA	Moville AFA	Newtown Cunningham AFA	Ramelton AFA	Rathmullan AFA
High-End Future Scenario							
Event Damage (€)	293,327,684 Fluvial 208,862,263 Coastal	32,840,356	23,042 Fluvial 3,560,923 Coastal	1,900,284 Fluvial 3,767,456 Coastal 3,231,541 Coastal 2	0 Fluvial 0 Coastal	5,769,657 Fluvial 10,512,958 Coastal	907,624 Fluvial 3,805,477 Coastal 697,022 Coastal 2
Residential Properties	121 Fluvial 67 Coastal	66	1 Fluvial 17 Coastal	17 Fluvial 21 Coastal 21 Coastal 2	0 Fluvial 0 Coastal	19 Fluvial 27 Coastal	8 Fluvial 42 Coastal 13 Coastal 2
Business Properties	157 Fluvial 131 Coastal	54	1 Fluvial 11 Coastal	0 Fluvial 5 Coastal 4 Coastal 2	0 Fluvial 0 Coastal	15 Fluvial 23 Coastal	0 Fluvial 5 Coastal 0 Coastal 2
Utilities	0 Fluvial 0 Coastal	1	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Major Transport Assets	59 Fluvial 46 Coastal	9	7 Fluvial 9 Coastal	3 Fluvial 4 Coastal 4 Coastal 2	0 Fluvial 0 Coastal	7 Fluvial 7 Coastal	6 Fluvial 8 Coastal 3 Coastal 2
Highly Vulnerable Properties	0 Fluvial 0 Coastal	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2
Social Infrastructure Assets	43 Fluvial 31 Coastal	8	0 Fluvial 0 Coastal	5 Fluvial 4 Coastal 2 Coastal 2	1 Fluvial 0 Coastal	3 Fluvial 3 Coastal	0 Fluvial 2 Coastal 0 Coastal 2
Environmental Assets	7 Fluvial 7 Coastal	3	0 Fluvial 3 Coastal	2 Fluvial 2 Coastal 1 Coastal 2	2 Fluvial 2 Coastal	4 Fluvial 4 Coastal	3 Fluvial 4 Coastal 3 Coastal 2
Potential Pollution Sources	0 Fluvial 0 Coastal	0	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal	0 Fluvial 0 Coastal 0 Coastal 2

Table 5.2 Potential Options UoM01

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
UoM01	-	-	Sustainable Planning and Development Management Public Awareness Campaign	-	-	-	-	-	-	-	-
Ardara	1% Fluvial	16	Maintain Existing Regime Option 1 – Land Use Management	€369,183	€65,713	-	-	-	-	Moderate	Moderate
Ballybofey & Stranorlar	1% Fluvial	59	Option 1 – Hard Defences	€10,019,962	€3,044,411	€2,255,425	1.35	-222	-98.503	High	High
			Option 2 – Hard Defences & Improvement of Channel Conveyance	€10,019,962	€3,044,411	€2,294,266	1.33	-517	-225.42		
			Option 3 – Hard Defences & Improvement of Channel Conveyance	€10,019,962	€3,044,411	€1,918,918	1.59	-452	-235.636		

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
Bridge End	1% Fluvial	1	Option 1 – Hard Defences	€488,280	€234,084	€269,181	0.869	-392	-1457	Moderate	Moderate
Bunbeg-Derrybeg	1% Fluvial 0.5% Coastal	3	Option 1 – Hard Defences	€ 1,976,132	€ 1,177,759	€ 1,356,215	0.87	-46.16	-34.032	Moderate	Moderate
Buncrana	1% Fluvial	32	Option 1 – Hard Defences	€65,407,625	€15,795,333	€ 3,320,820	4.76	1050	316.152	High	High
			Option 2 – Hard Defences & Storage	€65,407,625	€15,795,333	€ 4,019,585	3.93	970	241.289		
			Option 3 – Hard Defences & Relocation of Properties	€65,407,625	€15,795,333	€ 17,414,028	0.91	1091	62.6291		

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
Burnfoot	1% Fluvial	22	Option 1 – Hard Defences	€1,337,686	€1,083,785	€1,232,762	0.88	16	12.96	Low	Low
Carndonagh	1% Fluvial	42	Option 1 – Hard Defences, Storage & Improvement of Channel Conveyance	€ 19,311,962	€ 11,183,906	€ 5,057,299	2.21	1279	252.86	Moderate	High
			Option 2 – Hard Defences & Storage	€ 19,311,962	€ 11,183,906	€ 4,841,059	2.31	1359	280.68		
Castlefinn	1% Fluvial	35	Option 1 – Hard Defences	€4,424,182	€2,647,436	€1,744,780	1.52	1159	664.292	Moderate	Moderate
Clonmany	1% Fluvial	9	Option 1 – Hard Defences & Individual Property Protection	€219,290	€79,045	€113,140	0.70	489	4318.51	Moderate	Moderate
			Option 2 – Hard Defences & Individual Property Protection	€219,290	€79,045	€96,909	0.82	489	5041.8		

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
			Option 3 – Individual Property Protection	€219,290	€79,045	€145,718	0.54	-	-		
Convoy	1% Fluvial	9	Option 1 – Hard Defences	€3,368,461	€1,622,255	€ 1,943,101	0.84	-65	-33.593	Moderate	High
Donegal	1% Fluvial 0.5% Coastal	73	Option 1 – Hard Defences & Storage	€ 30,947,533	€ 10,343,518	€ 8,499,574	1.22	388	45.76	High	High
Downings	0.5% Coastal	4	Option 1 – Hard Defences	€ 2,325,826	€ 1,375,658	€872,649	1.58	102	116.603	Moderate	Moderate
			Option 2 – Hard Defences & Improvement of Channel Conveyance	€ 2,325,826	€ 1,375,658	€853,392	1.61	-34	-40.129		
			Option 3 – Hard Defences & Flow Diversion	€ 2,325,826	€ 1,375,658	€ 717,073	1.92	-49	-68.677		

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
Dunfanaghy	0.5% Coastal	37	Option 1 – Hard Defences	€2,908,501	€2,494,322	€1,925,649	1.3	239	124.361	High	High
Dungloe	0.5% Coastal	2	Option 1 – Hard Defences	€ 503,444	€ 82,296	€ 188,163	0.44	23	121.47	Moderate	Moderate
			Option 2 – Hard Defences & Relocation of Properties	€ 503,444	€ 82,296	€ 184, 167	0.45	23	124.11		
Glenties	1% Fluvial	8	Option 1 – Hard Defences & Land Use Management	€11,933,179	€2,777,165	€550,066	5.05	416	756.20	Moderate	High
Kerrykeel	1% Fluvial	13	Option 1 – Other Works (Bridge Removal)	€190,579	€88,148.	€ 31,017	2.84	32	1017.48	Low	High

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
Killybegs	1% Fluvial 0.5% Coastal	49	Option 1 – Hard Defences	€ 38,784,131	€ 13,283,496	€ 8,412,168	1.58	1547	183.85	High	High
Killygordon	1% Fluvial	0	Maintain Existing Regime	€0	€0	-	-	-	-	Low	Low
Letterkenny	1% Fluvial 0.5% Coastal	41	Option 1 – Hard Defences & Improvement of Channel Conveyance	€35,065,807	€20,691,109	€4,227,803	4.89	307	72.7026	High	High
			Option 2 – Hard Defences & Improvement of Channel Conveyance	€35,065,807	€20,691,109	€6,117,917	3.38	307	50.2413		
			Option 3 – Hard Defences & Improvement of Channel Conveyance	€35,065,807	€20,691,109	€4,639,738	4.46	427	92.0074		
			Option 4 – Hard Defences & Improvement of Channel Conveyance	€35,065,807	€20,691,109	€6,434,035	3.22	451	70.08		

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
Lifford	1% Fluvial	78	Option 1 – Hard Defences	€ 21,727,532	€11,321,846	€5,942,907	1.91	1705	286.886	High	High
Malin	0.5% Coastal	5	Option 1 – Other Works	€ 242,632	€206,512	146,069	0.28	184	1260.15	Moderate	Moderate
Moville	1% Fluvial 0.5% Coastal	19	Option 1 – Hard Defences	€ 860,706	€ 705,484	€ 721,441	0.98	220	305.39	High	High
Newtown Cunningham	1% Fluvial 0.5% Coastal	0	Maintain Existing Regime	€ 0	€ 0	-	-	-	-	Low	Low
Ramelton	0.5% Coastal	30	Option 1 – Hard Defences	€13,773,533	€6,938,340	€7,354,364	0.94	819	111.42	High	High

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
			Option 2 – Hard Defences & Do Minimum	€13,773,533	€6,938,340	€6,791,603	1.02	823	121.25		
Rathmullan	1% Fluvial 0.5% Coastal	21	Option 1 – Hard Defences	€14,724,149	€7,442,165	€4,459,525	1.67	623.04	139.71	Low	Moderate
			Option 2 – Hard Defences & Improvement of Channel Conveyance	€14,724,149	€7,442,165	€4,388,702	1.7	543.04	123.74		

6 THE DEVELOPMENT OF THE UoM01 DRAFT FLOOD RISK MANAGEMENT PLAN

6.1 DRAFT FLOOD RISK MANAGEMENT PLAN

The development of the draft Flood Risk Management Plans (FRMPs), which are the statutory output of the CFRAM studies, was led by the OPW. The OPW produced a template and undertook a series of consultations within the OPW, with other relevant government departments, national groups and the CFRAM Study Consultants.

The zero draft of the template was produced for comment in July 2015. It was intended to indicate the overall format of the draft FRMP, and in particular, to identify the sections to be completed by the Consultants, and the structure of some template tables and forms that the OPW required to be used in order to facilitate reporting to the European Union, Common Implementation Strategy Working Group. A workshop with relevant FRAM Section Engineers and RPS personnel was held in early May 2016 to discuss an initial version of the UoM07 draft FRMP (within the Eastern CFRAM Study area) and agree the level of detail required.

Revision C of the draft FRMP was produced by the OPW in May 2016, this version, incorporating later additions and policy updates, formed the basis of the draft plans that were consulted on during the second half of 2016.

The UoM specific material (text, maps and datasets) were populated by the CFRAM Study consultants drawing largely on the supporting technical studies on hydrology, hydraulics and the preliminary options assessments. The Progress Group reviewed the draft plans, with the OPW examining with regard to both project-level detail and also national consistency, while the Local Authority Progress Group members provided local knowledge, and information about relevant plans and programmes, previous projects. They also influenced the selection of the preferred measures identified within the draft plans.

Within the draft plans some AFAs were found to have low predicted levels of risk to properties. The Preliminary Options Reports contain detail of minor localised works for some of these low-risk AFAs that were not considered significant enough for inclusion in the draft FRMP, but that may be examined further and developed through, for example, the Minor Works programme. It should be noted that a low level of predicted risk to existing property does not equate to there being no predicted flooding in an AFA, and the requirements of the Planning System and Flood Risk Management Guidelines should still be applied to ensure future development takes account of the predicted flood hazard present. Within UoM01 there were seven very low risk AFAs, namely Ardara, Bridge End, Clonmany, Dungloe, Killygordon, Malin and Newtown Cunningham AFAs.

The draft plans are supported by the final core hazard and risk mapping (Volume I) dictated by the Floods Directive and the statutory environmental assessments (Volume II, under the Strategic

Environmental Assessment (SEA) Directive and the Habitats Directive. The environmental assessment process, which resulted in an SEA Environmental Report and Natura Impact Statement, influenced:

- the development and assessment of measures,
- the selection of preferred measures,
- the identification of mitigation measures and
- an environmental monitoring programme during the Plan's implementation.

Key Findings:

The draft FRMP is a consultation document which provides a nationally consistent roadmap to manage flood risk on a proactive basis.

The draft plan incorporates a suite of certain prevention and preparedness measures related to flood risk management that form part of wider Government policy. These measures, set out below, where applicable may be applied across the whole of UoM01, including selected AFAs:

- ***Sustainable Planning and Development Management***
- ***Sustainable Urban Drainage Systems***
- ***Voluntary Home Relocation***
- ***Local Adaptation Planning***
- ***Land Use Management and Natural Flood Risk Management Measures***
- ***Maintenance of Arterial Drainage Schemes***
- ***Maintenance of Drainage Districts***
- ***Flood Forecasting and Warning***
- ***Review of Emergency Response Plans for Severe Weather***
- ***Promotion of Individual and Community Resilience***
- ***Individual Property Protection***
- ***Flood-Related Data Collection***
- ***Minor Works Scheme.***

No measures were identified at Sub-Catchment scale however the following AFA specific measures were identified under the North Western Neagh Bann CFRAM Study:

- ***Ballybofey & Stranorlar Flood Relief Scheme: Hard Defences and Improvement of Channel Conveyance***
- ***Bunbeg-Derrybeg Flood Relief Scheme: Hard defences***
- ***Buncrana and Luddan Flood Relief Scheme: Hard Defences***
- ***Burnfoot Flood Relief Scheme: Hard defences***
- ***Carndonagh Flood Relief Scheme: Storage, Hard Defences, Improvement of Channel Conveyance***

- ***Castlefinn Flood Relief Scheme: Hard defences***
- ***Convoy Flood Relief Scheme: Hard defences***
- ***Donegal Flood Relief Scheme: Hard defences and Storage***
- ***Downings Flood Relief Scheme: Hard defences***
- ***Dunfanaghy Flood Relief Scheme: Hard defences***
- ***Glenties Flood Relief Scheme: Hard Defences and Land Use Management***
- ***Kerrykeel Flood Relief Scheme: Other Works***
- ***Killybegs Flood Relief Scheme: Hard defences***
- ***Letterkenny Flood Relief Scheme: Hard Defences and Improvement of Channel Conveyance***
- ***Lifford Flood Relief Scheme: Hard defences***
- ***Moville Flood Relief Scheme: Hard defences***
- ***Ramelton Flood Relief Scheme: Hard Defences and Do Minimum***
- ***Raphoe Relief Scheme: Hard defences, upstream storage, diversion of flow and overland floodway (identified under separate study but included in UoM01 draft Flood Risk Management Plan)***
- ***Rathmullan Flood Relief Scheme: Hard Defences and Improvement of Channel Conveyance.***

It should be noted that the policy regarding mechanisms to support relocation and individual property protection continued to evolve between the preliminary option reporting and draft plan finalisation.

Furthermore, whilst public consultation was undertaken on the preliminary options there was a relatively low level of public engagement that facilitated revision or refinement of the options. RPS considers that this is, in part, due to the good level of engagement with the North Western Neagh Bann CFRAM Study Progress Group, Stakeholder Group and the OPW representatives who reviewed the options ahead of public consultation. It should also be acknowledged, however, that attendance at Public Consultation days was often low.

A common theme throughout the CFRAM Study consultation process was the need for a programme of when the measures would be implemented. The draft plans did not have such an overall programme as this is dependent on the outcome of the consultation process, however, it is intended and there is a strong expectation, that the final plan will contain a finalised and prioritised implementation programme of measures. The key information fields to be prepared, in order to facilitate the prioritisation process, are presented in Appendix A.

6.2 DRAFT FRMP CONSULTATION & DEVELOPMENT OF THE FINAL FRMP

Project-level consultation activities took place early 2016 in relation to the draft Flood Risk Management Plans produced by the North Western Neagh Bann Catchment-based Flood Risk Assessment and Management (CFRAM) Study. These comprised workshops with the North Western Neagh Bann CFRAM Progress Group, a stakeholder workshop and a series of Public Consultation Days were also held.

These Public Consultation Days took place during October 2016, at the following locations (Lifford, Letterkenny, Carndonagh, Dungloe and Donegal Town).

The main objective of Public Consultation Days was to support the formal consultation process, especially by raising the awareness of how submissions relating to draft plans could be provided to the OPW for consideration.

Formal, national-level consultation in support of the draft plans and supporting environmental assessments was undertaken in parallel during late 2016 by the OPW, comprising briefings to elected members, a website based portal for access to the draft plans and supporting materials and to make on-line submissions and also statutory consultation in relation to the supporting environmental assessments.

The formal consultation period was open to the public between 19/08/16 and 28/10/16. The OPW received formal submission via the portal and also in written format and in total received 40 formal submissions.

The OPW, with technical support from RPS, collated responses and reported statutory consultation on the draft FRMPs for UoMs 01, 06 and 36 separately within a series of Public Consultation Synthesis Reports relating to each Unit of Management.

The OPW hosted an environmental workshop at national technical co-ordination level, on 13th February 2017, to consider the environmental issues raised in the consultation responses on the draft plans and supporting environmental reports with a view to developing standard environmental mitigations.

A workshop at project-level was held with relevant FRAM Section Engineers and RPS personnel in late February 2017 to discuss the NWNB CFRAM consultation submissions in relation to the UoM36 draft FRMP and agree the actions required to reflect these in the final FRMP.

The development of the final FRMPs was again led by the OPW through the production of a template. The OPW undertook a series of consultations within the OPW, with other relevant government departments, national groups and the CFRAM Study Consultants and considered the submissions made on the national suite of draft FRMPs.

The template was provided for information on the 10/04/17 (revision A-3) with guidance on the key changes and updates required within the final plans, and as near final on the 18/05/17 (revision C-0) noting further updates and insets to be supplied (executive summary and mapping). Version C.1 of the template was received 15/06/17.

The UoM specific material (text, maps and datasets) were again populated by the CFRAM Study consultants where appropriate updating the material from the draft FRMP. The Progress Group again reviewed the final plans, with the OPW examining with regard to both project-level detail and also national consistency, while the Local Authority Progress Group members provided local knowledge, and updated information about relevant plans, programmes and previous projects.

The OPW undertook consultation and prioritisation of the preferred measures identified within the final plans and published these separately in a National Flood Relief Capital Investment Programme which complements Ireland's final FRMPs.

The final plans are also supported by statutory environmental assessments (Volume II), under the Strategic Environmental Assessment (SEA) Directive and the Habitats Directive and drafts of the final statements for these assessments which remain subject to amendment until formal adoption of the plans

Key Findings:

The final FRMP responded to consultation submissions which related to inter alia, development in national policy, environmental requirements and National Flood Relief Capital Investment Programme. Modifications were also incorporated to make the final plans more nationally consistent.

The final plan generally contained a preferred measure for each AFA (unless there were requirements for further study to determine a preferred option). Whilst the consultations and submissions on the draft FRMP provided valuable information, which has been noted for detailed design, none resulted in a change of the preferred measures for the AFAs within UoM01.

The final FRMP measures for UoM01 are presented in Table 6.1.

Table 6.1 Summary of Flood Risk Management Measures

Measure	Implementation	Funding
Measures Applicable for All Areas		
Application of the Guidelines on the Planning System and Flood Risk Management (DECLG/OPW, 2009)	Planning Authorities	Planning Authorities
Implementation of Sustainable Urban Drainage Systems (SUDS)	Planning Authorities	Planning Authorities
Voluntary Home Relocation	Inter-Dept. Flood Policy Review Group	Homeowners, OPW (2017 Scheme)
Consideration of Flood Risk in Local Adaptation Planning	Local Authorities	Local Authorities
Assessment of Land Use and Natural Flood Risk Management Measures	EPA, OPW, Others	OPW, Others
Minor Works Scheme	OPW, Local Authorities	OPW, Local Authorities
Establishment of a National Flood Forecasting and Warning Service	OPW, D/HPCLG, Met Éireann and local authorities	OPW, D/HPCLG
Ongoing Appraisal of Flood Event Emergency Response Plans and Management Activities	Principal Response Agencies, Regional Steering Groups, National Steering Group	Implementation Bodies
Individual and Community Action to Build Resilience	Public, business owners, farmers and other stakeholders	N/A
Individual Property Protection	Home Owners, Inter-Dept. Flood Policy Review Group	Homeowners
Flood-Related Data Collection	OPW, Local Authorities / EPA, and other hydro-meteorological agencies	Implementation Bodies
Catchment / Sub-Catchment Measures		
No Sub-Catchment methods were found to be feasible		

Community-Level (AFA) Measures		
Progress the project-level development and assessment of a Flood Relief Scheme, including environmental assessment as necessary and further public consultation, for refinement and preparation for planning / exhibition and, if and as appropriate, implementation, for the Communities set out below.		
Ballybofey and Stranorlar AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Buncrana and Luddan AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Carndonagh AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Castlefinn AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Donegal AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Downings AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Dunfanaghy AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Glenties AFA	Typically the local authority under the OPW Minor Works Scheme	Typically OPW Minor Works Scheme
Kerrykeel AFA	Typically the local authority under the OPW Minor Works Scheme	Typically OPW Minor Works Scheme
Killybegs AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Letterkenny AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Lifford AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Ramelton AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Raphoe AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Rathmullan AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Progress further Data Collection and/or further Analysis for the Communities set out below.		
Raphoe Flood Relief Scheme	OPW and/or Donegal CoCo - To be confirmed	OPW
Undertake a Detailed Assessment of the Costs of the Potential Measure for the Communities set out below.		
Bunbeg-Derrybeg AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Burnfoot AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Convoy AFA	OPW and/or Donegal CoCo - To be confirmed	OPW
Moville AFA	Typically the local authority under the OPW Minor Works Scheme	Typically OPW Minor Works Scheme

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 TECHNICAL

The North Western Neagh Bann CFRAM Study was a significant and challenging project in terms of the detailed analysis it required, simultaneously across its two international districts and three Units of Management, and in the context of a suite of similar studies nationwide.

The level of ambition to undertake catchment scale studies of this nature created a significant resource demand on many of the parties involved, including the organisations represented on project progress, steering and stakeholder groups. In particular, a shortfall in third party survey resources introduced a programme delay, of over one year, which meant that the final consultation deliverables (draft FRMP and accompanying documentation) were prepared in 2016, rather than 2015 as originally programmed. The pre-contract survey programme was a valid endeavour to try to spread the survey workload, but was not sufficiently progressed ahead of the CFRAM studies, and also allowed there to be a disconnect between the survey specification and the modeller requirements (this means that a supplementary survey arrangement needed to remain in place until model validation was complete). RPS was able to review pre-contract specifications and tailor these to reduce survey programme and costs and ultimately progress all of the North Western Neagh Bann survey under a single tender action. To inform future Floods Directive planning cycles, RPS would suggest that the main CFRAM studies in this first cycle should have started earlier (in the period when the pre-contract survey arrangements were being progressed) with more programme allowance for the surveys to be distributed, thus allowing staged delivery of Units of Management on all survey and subsequent deliverables. In addition, RPS would recommend that the Survey Framework is renewed so that support for post-CFRAM Study activities, such as responding to comments and queries regarding mapping and updates, remains in place.

Due to the survey related programme delay, it was decided to prioritise the development of the mapping specifically required for submission to the EU Commission from the rest of the mapping deliverables, so that, statutory consultation and reporting obligations in relation to these “core deliverables” could be discharged as soon as possible within the revised programme. This focus had the additional benefit of avoiding re-working of huge numbers of maps is not required with each iteration of the core extent and depth mapping. It is recommended that this de-coupling of mapping deliverables would be incorporated into future planning cycles as it permits the earliest consultation on the mapping which the public and stakeholders are most readily engaged regarding as well as avoiding nugatory re-working.

In some cases, the study programme had to be prioritised in response to flood risk or events. This was beneficial in terms of piloting, and agreeing, the detail of methodologies, providing results for particular watercourses or AFAs to allow certain projects to progress, and also dissemination of lessons learned from the process. The acceleration also shortened the programme duration for these areas and

therefore reduced the risk of further interventions resulting in reworking of analysis which has been an ongoing project challenge. Based on this, RPS would recommend a prioritised approach to subsequent Floods Directive activities so that the completion of analysis for the final areas is not allowed to delay progress for the other areas. Such a staged approach has been adopted for the consultations on the draft plans and offers the benefit of smoothing resource needs for activities such as statutory consultations.

In some AFAs or watercourses there was insufficient information to provide high confidence in the analysis of flood risk and this can only be redressed by collecting data as and when events occur. However the best use of available data was made so that in most cases recommendations could be made to progress flood risk management measures without recourse to further study. In other areas where data was sufficient, and especially where site visits to areas that experienced flooding were undertaken during the study, there was more confidence in the findings and these could readily be displayed to the wider public audience. Communities subject to recent events are understandably sensitive, and must be dealt with sympathetically, however in every location where this had occurred RPS were especially well received once it was known that there had been recording of the event to inform the CFRAM Study process. The Flood Event Response enabled complex mechanisms to be better understood and replicated (for example in the Letterkenny and Finn systems) and this task is a valuable activity for those undertaking the modelling to be involved with.

The “live” nature of some of the tasks was challenging and led to reworking of deliverables and delayed closure of certain tasks. Whilst tasks were initially envisaged as sequential under the specification, for example finalised hydrology available in advance of final hydraulics and mapping consultation, this was not a realistic expectation and RPS advocated this from the study’s outset which led to the establishment of an infill survey contract to allow further data collection if any problems were encountered during hydrological and hydraulic analysis.

In addition, there were competing demands on the time of the Progress Group members which meant that they could not always provide the information needed or respond to requests to meet the NWNB CFRAM Study timescales. To try to facilitate engagement with the progress group, in an efficient manner for all parties, RPS held a series of workshops with Local Authority engineering and planning personnel at key study stages. RPS found this addition to be a useful mechanism to ensure the quality of the modelling outputs and the optioneering and would recommend this approach for future stages.

In particular, there was ongoing uncertainty with regard to the defence asset database, which was populated during the study, but is “live” and therefore needs continual review and update, RPS would suggest that this particular task should have preceded the main study (with an update element and surveys included under the North Western Neagh Bann CFRAM Study). Having populated the database during this cycle to the degree possible, it is important that the database is maintained centrally for future use.

Also in relation to the status of defences, a significant issue arose in determining whether defences were effective or ineffective. In many cases the design or as-built information required to establish effectiveness was not available, and there is a liability issue with assuming effectiveness for a structure where no such information is available, and the scope of the CFRAM Study did not extend to the level of detail required to determine effectiveness, in terms of site investigation or structural assessment. Hence, such structures were omitted from the models. While this is a failsafe approach from the OPW/RPS perspective by avoiding the indication of areas as “protected” when, in fact, the structural performance cannot be confirmed, it poses difficulties for property owners and other stakeholders within these areas which are now indicated to have no protection, thus leading to difficulties in obtaining insurance and other permissions. In order to address this further assessment of the defence performance and a policy review regarding the mapping of such areas would need to be carried out, possibly accompanied by provision of relevant information to the insurance industry.

7.2 COMMUNICATIONS

Communications are often a challenge on projects of this complex nature and duration. This is applicable at a number of levels:

- The North Western Neagh Bann CFRAM Study benefitted from the regular and ongoing communication between the OPW FRAM project engineers and that of RPS with key personnel remaining engaged throughout the study’s duration, providing regular updates and participating in focussed workshops.
- The North Western Neagh Bann CFRAM Study’s Progress Group engaged well throughout the study, benefiting from personnel who were involved together in previous catchment scale flood risk management studies, from Local Authority for whom flood management comprises a large part of their duties, and who have significant amounts of relevant, local knowledge. The resource demands that a study of this nature put on Local Authority partners, and their support and engagement is fully acknowledged. During this first stage the study adopted an integrated Progress/Steering Group approach. A recommendation for future CFRAM groups would be consideration of how best to engage with more Senior Local Authority staff via Steering Group meetings or alternative approaches.
- Early collaboration via a National Technical Co-ordination group was of some benefit, despite the group’s large membership, these two day meetings evolved into targeted workshops on specific topics. RPS would suggest that further such workshops would have been of benefit in the latter stages of the projects and whilst the OPW’s production of the draft plan template and covers, and their review of the draft Plans, ensured a reasonable degree of consistency, this may have been facilitated by the continuation of the co-ordination group or workshops engendering more of an ethos of partnership and providing more direct communication and access to policy level decision. For example, specific topics could have been; the use of the unit cost database and inputs to the draft FRMP.

- The longevity of the studies posed difficulties in terms of achieving and maintaining engagement with stakeholders and the wider public. RPS would endorse our early views that the quality, rather than quantity, of consultation events remains the focus of future consultation phases, that the publicising the events is given a high priority going forward with engagement of national groups under an overall communications strategy, opportunities to tap into similar local engagement programmes are utilised (for example WFD engagement), and, that information be made available using flexible electronic visualisation applications as well as hard copy deliverables.
- It is noted that the OPW are already engaged with a number of relevant groups, for example national stakeholders and cross border fora, which are beyond the remit of the CFRAM studies to review. However it is considered important that all engagement is maintained.

Within the realm of communications RPS found the use of key messages during every formal presentation to be helpful with managing expectations. This was complemented by using less technical language and both addressing, and clearly communicating, the confidences and uncertainties in the process and its outcomes.

It should be noted that at all stages of North Western Neagh Bann CFRAM consultation there was extensive public and stakeholder interest in a broader range of flooding issues than the fluvial/coastal first cycle remit of this CFRAM Study; for example (regarding flooding due to groundwater, pluvial, urban drainage, etc). As a result the project-level target audience is relatively narrow, and difficult to reach, without bringing in a lot of other parties that the project is not relevant for. There are also a significant number of policy-level activities being progressed by the OPW, or that the Inter-Departmental Flood Policy Coordination Group are responsible for, which are relevant to the draft Plans, but which are not covered at a project-level, meaning that they are very difficult to address during project-level consultation activities. These issues could not be fully addressed within the first CFRAM cycle timescale and will need to be developed further, possibly in the context of continued national stakeholder engagement activities to address these flooding issues.

Again, through the communications process, it was evident that there was a significant disconnect between the objective of the CFRAM Study to achieve a 1% AEP standard of protection, and that of a public aspiration of betterment/improvement in existing levels of protection which would not necessarily be to that standard. These works may be viable where providing the 1% AEP standard of protection in these situations may not be feasible. Such solutions may be implemented by Minor Works or watercourse maintenance/drainage works (which provide a different standard of protection than the Improvement of Channel Conveyance measures considered within the scope of the CFRAM Studies).

7.3 GENERAL

Throughout the process there was a degree of conflict between maintaining a strategic and plan level of detail, to develop a catchment-scale plan, and the need to address the often very localised issues and nuances to particular flooding problems. In all relevant cases, it should be recognised that the subsequent analysis for progressing detailed design will involve some degree of remodelling to account for site investigations, service details, land owner requirements, and consequently this type of study provides “line and level” solutions with variations and refinements to be realistically expected in subsequent stages.

There are many peripheral, but nevertheless valuable, activities which could have been further explored within the Floods Directive’s first cycle assessment; however, due to the number of AFAs which were being assessed and brought together for catchment-scale analysis, focus had to be maintained on the project’s core activities. Whilst other analyses were piloted within various studies (for example culvert blockage, Natural Flood Risk Management and detailed climate change adaptation) these were not able to be implemented across the country due to programme constraints. RPS would recommend that such additions and innovations are taken forward during the Flood Directive’s second cycle alongside the implementation of the first cycle’s plans. In particular, RPS would recommend trialling/piloting measures, such as Natural Flood Risk Management and wetland/bog restoration, which may be of mutual benefit to the implementation of the Water Framework and Habitats Directives, as these integrated catchment measures are untested in the Irish context but may be relevant tools to help offset the impacts of future changes assessed under the first cycle of CFRAM studies and provide benefit where structural schemes are not financially viable.

The project has enabled the collation and development of a very detailed and valuable dataset of flood risk management information. It has provided a strong evidence base to enable strategic decisions to be taken on how best to manage flood risk within UoM07 and across the Eastern CFRAM Study area. It has also provided sufficient clarity to allow, for the first time, a national prioritisation process to be undertaken in support of the final plans. The prioritised programme for the advancement and implementation of ongoing flood relief projects and also the flood protection measures set out within the FRMPs provides the basis for the short and long term planning for flood risk management expenditure in Ireland.

Importantly the project also identified weaknesses, such as where additional flooding mechanisms are still not fully understood or the risk could not be quantified sufficiently. Part of the next step will be to study these areas in more detail to further inform the planning of flood risk management into the next cycle of the Floods Directive and beyond.

The CFRAM studies in this first cycle were ambitious and whilst they had been informed by pilot studies there were areas where the methodology was untested at a CFRAM Study scale which led to some delays and iteration throughout the process. The methodology and scope for the second cycle

should be developed as soon as possible to enable pilot studies and trials to be undertaken and a realistic programme to be developed. This should enable more efficient working in the next cycle.

8 REFERENCES & BIBLIOGRAPHY

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9. North Western Neagh Bann CFRAM Study, UoM01 Preliminary Options Report, IBE0700Rp0017 (RPS, 2016)
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APPENDIX A

KEY INFORMATION UOM01

FIELD NAME DESCRIPTION

1 RBD Name of the RBD / IRBD

2 UoM No. The number of the UoM, as per Appendix A of the Note on the Format of Measure Codes (18/05/16)

3 AFA Code If at AFA level, the number of the AFA, as per Appendix C of the Note on the Format of Measure Codes (18/05/16) - If measure is at UoM / Catchment level, insert '-999'

4 AFA Name If at AFA level, the name of the AFA, else leave blank

5 Measure Name The name of the measure

6 Code The Measure Code

7 Measure Description The short description of the measure

8 Implementation The name(s) of the nominated body or bodies responsible for implementation of the measure

9 Funding The name(s) of the nominated body or bodies responsible for funding of the measure

10 Type of Measure The Type of Measure Code, as per Appendix B of the Note on the Format of Measure Codes (18/05/16)

11 1.a.i Unweighted MCA score for the Objective (1.a.i) – Social - Human Health

12 1.a.ii Unweighted MCA score for the Objective (1.a.ii) – Social - High Vulnerability Properties

13 1.b.i Unweighted MCA score for the Objective (1.b.i) – Social - Social Infrastructure

14 1.b.ii Unweighted MCA score for the Objective (1.b.ii) – Social - Local Employment

15 2.a Unweighted MCA score for the Objective (2.a) - Economic - Economic Risk

16 2.b Unweighted MCA score for the Objective (2.b) - Economic - Transport

17 2.c Unweighted MCA score for the Objective (2.c) - Economic - Utilities

18 2.d Unweighted MCA score for the Objective (2.d) - Economic - Agriculture

19 3.a Unweighted MCA score for the Objective (3.a) - Environmental - WFD

20 3.b Unweighted MCA score for the Objective (3.b) - Environmental - Natura Sites

- 21 3.c Unweighted** MCA score for the Objective (3.c) - Environmental - Flora and Fauna
- 22 3.d Unweighted** MCA score for the Objective (3.d) - Environmental - Fisheries
- 23 3.e Unweighted** MCA score for the Objective (3.e) - Environmental - Visual Amenity
- 24 3.f.i Unweighted** MCA score for the Objective (3.f.i) - Environmental - Cultural (architectural)
- 25 3.f.ii Unweighted** MCA score for the Objective (3.f.ii) - Environmental - Cultural (archaeological)
- 26 4.a Unweighted** MCA score for the Objective (4.a) - Technical - Operationally Robust
- 27 4.b Unweighted** MCA score for the Objective (4.b) - Technical - Health and Safety
- 28 4.c Unweighted** MCA score for the Objective (4.c) - Technical - Adaptability to Climate Change
- 29 MCA Benefit Score Weighted** total MCA Score (i.e., sum of weighted scores for each objective)
- 30 Cost (€m)** Cost of the proposed measures in €m
- 31 Uncapped NPVd (€m) Uncapped** value of Net Present Value Damages in €m
- 32 NPVb (€m)** Capped Net Present Value of Benefits of measure in €m
- 33 MCA BCR (score/€m)** MCA Benefit - Cost Ratio - **NOTE:** As per GN28, the MCA Score for the purposes of calculating the MCA Benefits **excludes** the scores for Technical Objectives
- 34 Economic BCR** Economic Benefit - Cost Ratio
- 35 No. Residential Properties Protected** No. of Residential Properties that would be protected by the proposed measure
- 36 No. Non-Residential Properties Protected** No. of Non-Residential Properties that would be protected by the proposed measure
- 37 Technical Uncertainty** A ranking of the technical uncertainty as 'High', 'Medium' or 'Low' - This should reflect the uncertainty in technical parameters such as hydrological flows, flood levels, flood extents, etc. A description of each ranking category is provided below.
- High - There is significant uncertainty - Further data capture (e.g., hydrometric monitoring) is strongly required before the measure is advanced
- Medium - There is moderate level of uncertainty - Further should be collected if possible in advance of or during the progression of the development stage of the measure, but this data is not deemed critical before the measure may advance

Low - There is a low level of uncertainty, and, providing a reasonable freeboard / safety factor is allowed, the measure may progress without further data collection

38 Technical Uncertainty Comment A brief (2-3 lines) explanation as to why the Technical Uncertainty ranking assigned was selected

39 Project Risk A ranking of the risks in implementing the measure as 'High', 'Medium' or 'Low' - This should reflect the complexity and nature of the proposed measure, and what level of risk there may be to completing this measure within a defined timeline and the cost indicated. A description of each ranking category is provided below.

High - There are significant risks in progressing the measure, for example, the measure might involve complex construction, and/or, major works in confined urban areas, and/or significant environmental issues in advancing the measure (such as channel / river bank works in a protected Freshwater Pearl Mussel site)

Medium - There are moderate risks in progressing the measure, for example, a major construction project involving some construction in urban areas, or a smaller, but complex construction project, and/or moderate environmental issues in advancing the measure

Low - There are low risks in progressing the measure, for example, a construction project in a green-field site, with no particular environmental issues or risks

40 Project Risk Comment A brief (2-3 lines) explanation as to why the Project Risk ranking assigned was selected

41 Environmental Sensitivity/Impact A ranking of the likely environmental impact in implementing the measure as 'High', 'Medium' or 'Low' - This should reflect the derived from the outcome of the Strategic Environmental Assessment and/or the Appropriate Assessment.

42 Environmental Impact Comment A brief (2-3 lines) explanation as to why the Environmental Sensitivity/Impact ranking assigned was selected

43 AA Screening Required? Whether Appropriate Assessment Screening will be required at Project Level for that Measure / Location.