North Western Neagh Bann

CFRAM Study

Final Report

Unit of Management 36

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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 36

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 km^2 with approximately 7,400 km^2 of that area in Ireland. It includes two Units of Management (UoMs); UoM 01 (Donegal) and UoM36 (Erne). UoM36 includes hydrometric areas 35 and 36. It covers an area of 2,742 km^2 within Ireland. This report covers only the portion of the North Western UoM36 district within Ireland which includes the majority of County Cavan as well as areas of counties Leitrim, Monaghan and Longford, Donegal and Sligo.

The principal Irish river in UoM36 is the Erne (which drains part of County Cavan before crossing the border into Northern Ireland near Belturbet). The Erne River system includes numerous smaller rivers and streams such as the Annalee, Woodford and Finn rivers. Lakes in UoM36 include Lough Oughter, Lough Melvin and Lough Gowna as well as numerous other smaller lakes.

UoM36 is affected by fluvial flooding upstream of Lough Erne; downstream of Lough Erne Bundoran is affected by fluvial flooding and Tullaghan, on the coastline of Donegal Bay, by coastal flooding.

UoM36 is predominantly rural with the largest urban areas being Cavan town and Ballyshannon. The fertile soils of the Erne basin are capable of supporting intensive agriculture.

Within UoM36 the OPW has implemented and undertakes an annual programme to maintain the Abbey, Duff and Kilcoo Arterial Drainage Schemes which took place between 1964 - 1967, 1963 - 1965 and 1969 – 1971 respectively. These Arterial Drainage 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, all of which are located within river catchments less than 25,000 acres. 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 UoM36.

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 fourteen Drainage Districts located within UoM36, a number are located directly on the key watercourses where fluvial 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).

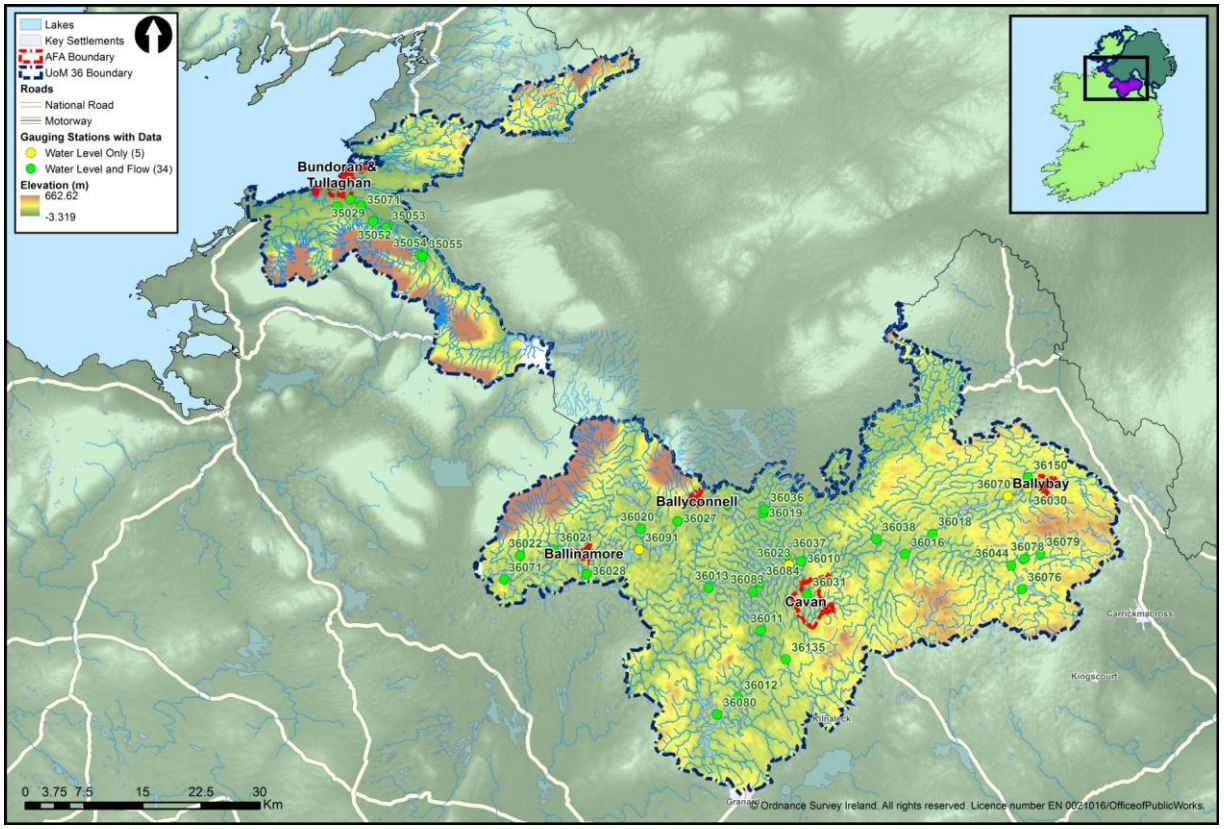

Figure 1.1: UoM36 Location Map

1.2 OBJECTIVE OF THIS REPORT

The principal objective of this final 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 UoM36 as part of the North Western Neagh Bann CFRAM Study, and; detail the development of the draft UoM36 Flood Risk Management Plan (FRMP), consulted on during the second half of 2016 and the finalisation of the UoM36 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 UoM36 Flood Risk Management Plan containing the following volumes:

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

This final report is also supported by a suite of project deliverables, including flood maps and key UoM36 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 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 – NWNB CFRAM Study Overall & UoM36 Specific Reports

Ref.	Document Title
Rp0001	IBE0700Rp0001_Communications Plan, Implementation Programmes & Event Plans • Initial Scoping Phase • Mapping Phase • Options Phase • Draft Plan Phase
Rp0004	IBE0700Rp0004_HA36 Inception Report
Rp0005	IBE0700Rp0005_Stakeholders Workshop No 1 Summary Report
Rp0007	IBE0700Rp0007_HA01, HA06 & HA36 North West Neagh Bann Survey Contract Report
Rp0009	IBE0700Rp0009_UoM36 Hydrology Report
Rp0010	IBE0700Rp0010_UoM36 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
Rp0019	IBE0700Rp0019_UoM36 POR
Rp0020	IBE0700Rp0020_E_SEA_Environmental_Report_D01 UoM36
Rp0023	IBE0700Rp0023_UoM36_NIS
Rp0028	N36_FRMP_PART01
Rp0029	IBE0700Rp0029_UoM36_draft final report
Rp0032	IBE0700Rp0032_Option Phase Summary Report
Rp0033	*IBE0700Rp0033 UoM36 Strategic SUDS Report*
Rp0036	*IBE0700Rp0036_UoM36 Strategic Planning Report*
Rp0032	IBE0700Rp0032_Draft Plan Phase Synthesis Report
Rp0042	IBE0700Rp0042_UoM36 Defence Asset Database Report
Rp0045	IBE0700Rp0045_UoM36 *CFRAM Study Preliminary Health & Safety Information*
Rp0041	IBE0700Rp0041_UoM36_SEA_Environmental_Statement
Rp0048	N36_FRMP_PART01 Flood Risk Management Plan
Rp0051	IBE0700Rp0051_UoM36_ Final Report (this report)
Rp0054	IBE0700Rp0054_Draft Plan Phase Summary Report
OPW	*UoM06 Consultation Synthesis report*

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 End point	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	
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) & (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 Health & Safety Information which has been reviewed by the PSDP and will be provided with the final project deliverables in 2017.

2 THE UOM36 INCEPTION REPORT

In 2012, an inception report was prepared for UoM36. Its principal objective was to provide detail on the relevant datasets identified for use in the Erne 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 UOM36 HYDROLOGY REPORT

In 2013, RPS commenced the preparation of the UoM36 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 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 UoM36.

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 UoM36 catchment can be characterised hydrologically as follows:

- The catchment has a wide range of climatic and physiographic characteristics. The drier, lowland areas in the Cavan River floodplain have SAAR values as low as 895 mm and as low as 900mm in the east of UoM36, while catchments in the upland areas of Donegal and Leitrim have SAAR values in excess of 1400mm.

- Hydrometric data is of good quality and availability for larger channels but is not available for many smaller modelled tributaries.

- Meteorological data is of good 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, generally more extreme in the upper catchment than would have been thought based on older methodologies (FSR) although there was a wide variance in pooled

frequency analysis for small to midsized catchments (10 to 200km^2) with some catchments displaying flatter growth curve behaviour than the regional FSR curve.

- The 1% AEP flood event ranges from approximately 1.7 to 3 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. In addition, cross-border catchment areas and associated catchment descriptors within the existing FSU database were found not to represent the Northern Ireland portions, proving a significant risk within the Lough Melvin catchment, requiring catchment characteristics adjustment using relevant datasets. Other cross border catchment areas downstream of Ballyconnell were also found not to be represented accurately but this was generally found to be a smaller area of the catchment and downstream of AFAs and as such has not been deemed a significant risk to the study.

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. ***All of the models within UoM36 have gauged data to inform the design flow estimation on the main channels; however, many of the small tributary watercourses are hydrologically quite different to the main channels being heavily attenuated due to lake/canalised***

sections. 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 provided within the draft plan to improve the availability of flood flow data at the existing gauging stations located within/upstream/downstream of AFAs. Following flood risk assessment the AFAs of Ballinamore, Ballyconnell, Bundoran and Tullaghan were shown to have very low or no flood risk. Furthermore, within the Cavan AFA the vast majority of the flood risk emanates from the gauged Cavan River and flood risk on the ungauged tributaries is relatively low. This is also the case at Ballybay where the vast majority of the flood risk emanates from the gauged Shantonagh River.

Improvements to the hydrometric network should focus on the existing gauging stations where there is scope to improve the data for use in flood flow analysis. This is particularly the case at Bundoran & Tullaghan (35029 Mullinaleck Bridge), on the Annalee River (36016 Rathkenny and 36037 Urney Bridge) on the Woodford River (36027 Bellaheady and Aghoo 36028), at Cavan (36031 Lisdarn) and at Ballybay (36150 Shantonagh Bridge) where existing stations could potentially be developed into A1 flood flow rated stations. It is assumed that the gauging stations within UoM36 which currently have a rating of A1 will be maintained to that standard into the foreseeable future.

2. ***The availability of high temporal resolution rainfall data can 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 06. This may take the form of additional hourly rainfall gauges or may involve the processing of radar data already available from the Dublin Airport radar or Castor Bay radar at Lough Neagh.***

3. ***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 UOM36 HYDRAULICS REPORT

Following delivery of UoM36 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.

UoM36 includes six AFAs which have resulted in the development of five separate models for flood risk analysis. A single model was developed for the Bundoran and Tullaghan AFAs, due to their proximity and hydraulic interaction.

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.

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 – this was not required within UoM36) 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 UoM36 in particular the 1%AEP fluvial (or 0.5%AEP coastal in the case of Tullaghan) design event are summarised as follows:

Ballinamore - Anecdotal information pertaining to flooding in and around the sports pitches on Railway Road is supported by the model results. Ballinamore AFA is considered to be at very low risk during the present day 1% AEP fluvial event. Fluvial flooding is predicted in the Ballinamore AFA during the 1% AEP event. Whilst there are no properties at flood risk in this area, there are local roads and one regional road (the R202) affected. A number of social infrastructure assets and environmental assets are at risk of flooding during this event.

Ballybay - There is good confidence in both the hydrology and hydraulics of the Ballybay AFA due to the presence of gauging stations and flood extent verification events. Fluvial flooding is predicted during a 1% AEP event in Ballybay. The main source of flooding is from the Shantonagh River and the Dromore River located downstream of Ballybay. There are three areas of flooding which interact with one another. The first is due to out of bank flooding on the Shantonagh River and the Cornamucklaglass River due to insufficient channel capacity inundating the floodplain. As the Shantonagh River progresses it flows through a series of culverts and bridges, some of which have been identified as critical structures causing raised water levels. During a 1% AEP event, flood water discharges into the lake downstream of the Shantonagh, Dromore and Corrybrannan Rivers, causing water levels to rise and affect the town. The combination of these areas is considered complex. There are also two other discrete areas of flooding; one is caused by flow from the Dromore River through the Corrybrannan

Bridge raising water levels in Lough Major whilst the other is caused by the out of bank flooding at a point in the Corrybrannan River. A number of both residential and commercial properties are at risk of flooding. Several roads including a regional road are also within these floodplains. A Waste Water Treatment Plant and several social infrastructure assets are situated in the areas affected by flooding during the 1% AEP flood event. As a result there are significant damages and risks in present day and future scenarios.

Ballyconnell - A partial verification exercise has been undertaken based on the data available. There is no flood risk within the AFA boundary at Ballyconnell however there are two discrete locations of flooding close to the boundary. Ballyconnell AFA is therefore considered to be at very low risk during the present day 1% AEP fluvial event. One area is caused due to low bank levels and marginally increased water levels upstream of a culvert on the Derrginny Tributary. The other flood area is due to flooding emanating from the left bank of Derryginny River. As these areas are along the same stretch of water, they can influence one another and the flooding is considered complex. There are a small number of residential properties and local roads affected, a national road and a number of social infrastructure assets.

Bundoran - There is moderate confidence in both the hydrology and hydraulics of the Bundoran model as there were limited flood extent verification events. The main source of flooding in Bundoran is from the Drumacrin River during the 1% AEP flood event. Water levels are raised upstream of a long culvert as it has insufficient capacity to convey the flow. This is a discrete location of flooding, affecting a small number of residential properties and a number of local roads. Bundoran AFA is therefore considered to be at very low risk during the present day 1% AEP fluvial event.

Tullaghan - There is moderate confidence in both the hydrology and hydraulics of the Tullaghan model as there were limited flood extent verification events. The main source of flooding in Tullaghan is caused by wave overtopping. This affects one apartment block during the 0.5% AEP coastal event. This is a discrete location with a number of residential properties at risk along with a local urban road. Tullaghan AFA is therefore considered to be at very low risk during the present day 0.5% AEP coastal event.

Cavan - There is good confidence in both the hydrology and hydraulics of the Cavan AFA due to the presence of gauging stations and flood extent verification events. The main flood risk within Cavan AFA is to receptors adjacent to the Cavan River, including water backing up into the Aghnaskerry. There are a number of areas along this stretch of watercourse with flooding occurring normally due to either insufficient channel capacity or insufficient culvert or structure capacity causing an increase in water levels leading to water breaking the banks. These areas can influence one another. There are also a number of other discrete areas where flooding is predicted again due to insufficient channel or culvert capacities during the 1% AEP

fluvial event. A waste water plant is at risk of flooding at the confluence of the Cullies and Cavan Rivers. A significant number of both residential and commercial properties are at flood risk within the areas along the Cavan and Aghnaskerry Rivers. There are also many social infrastructure assets at risk and utilities such as an electricity kiosk. Transport assets are located in the floodplains. There are several local roads, as well as regional roads and a national road. Properties at risk generate significant damages and risks in present day and future scenarios.

5 THE UoM36 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 UoM36 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 UoM36 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 Ballinamore, Ballyconnell, Bundoran and Tullaghan 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 low number of observations received which related to drainage issues relevant to Cavan AFA 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 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 UoM36 respectively.

Table 5.1 Flood Risk Analysis UoM36

(Fluvial statistics except Tullaghan AFA which refers to Coastal/ Wave Overtopping Flooding)

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event					
	Ballinamore AFA	Ballybay AFA	Ballyconnell AFA	Bundoran AFA	Cavan AFA	Tullaghan AFA
Current Scenario (Present Day)						
Event Damage (€)	0	11,021,442	253,167	69,623	8,400,132	485,829
No. Residential Properties at Risk	0	55	3	3	54	6
No. Business Properties at Risk	0	16	0	0	57	0
No. Utilities at Risk	0	2	0	0	5	0
No. Major Transport Assets at Risk	3	11	0	2	18	2
No. Highly Vulnerable Properties at Risk	0	0	0	0	1	0
No. of Social Infrastructure Assets at Risk	11	10	7	6	25	0
No. Environmental Assets at Risk	2	1	1	7	3	1
No. Potential Pollution Sources at Risk	0	0	0	0	0	0

Mid-Range Future Scenario						
Event Damage (€)	4,279,240	11,950,712	416,048	2,582,467	31,719,174	1,116,719
No. Residential Properties at Risk	19	65	4	34	117	11
No. Business Properties at Risk	4	18	1	3	97	0
No. Utilities at Risk	0	2	0	0	9	0
No. Major Transport Assets at Risk	5	16	0	10	31	4
No. Highly Vulnerable Properties at Risk	0	0	0	0	3	0
No. of Social Infrastructure Assets at Risk	11	11	8	8	32	0
No. Environmental Assets at Risk	2	1	1	7	3	1
No. Potential Pollution Sources at Risk	0	0	0	0	0	0
High-End Future Scenario						
Event Damage (€)	6,033,591	17,860,095	540,686	4,365,834	82,892,091	1,250,692
No. Residential Properties at Risk	24	73	4	45	209	12
No. Business Properties at Risk	8	23	1	6	190	0
No. Utilities at Risk	0	2	0	1	9	0
No. Major Transport Assets at Risk	5	16	1	21	45	4
No. Highly Vulnerable Properties at Risk	0	0	0	0	6	0
No. of Social Infrastructure Assets at Risk	12	11	8	8	39	0
No. Environmental Assets at Risk	2	1	1	7	3	1
No. Potential Pollution Sources at Risk	0	0	0	0	0	0

Table 5.2 Potential Options UoM36

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost (€m)	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
UoM36	-	-	Sustainable Planning and Development Management Public Awareness Campaign	-	-	-	-	-	-	-	-
Ballinamore	1% Fluvial	0	Maintain Existing Regime	€ 37,872	€ 0	-	-	-	-	High	High
Ballybay	1% Fluvial	71	Option 1 - Hard Defences	€ 25,670,309	€ 9,038,812	€ 3,638,237	2.48	1879	516.568	Moderate	High
			Option 2 - Hard Defences & Flow Diversion	€ 25,670,309	€ 9,038,812	€ 7,212,253	1.25	1477	204.85		
Ballyconnell	1% Fluvial	3	Hard Defences	€ 522,583	€ 477,828	€ 808,468	0.59	149	183.72	Moderate	Moderate
Bundoran	1% Fluvial	3	Maintain Existing Regime	€ 285,519	€ 20,989	-	-	-	-	Moderate	Moderate

AFA	Design flood event (AEP)	Number of properties at risk in design flood event	Options	Area NPVd	Option NPVb (capped)	Option Cost (€m)	Benefit – Cost Ratio	Total MCA-Benefit Score	MCA-Benefit Score / Cost Ratio	Sensitivity to MRFS	Sensitivity to HEFS
Cavan	1% Fluvial	110	Hard Defences	€ 11,002,417	€ 4,,419'902	€ 4,,440,075	1.00	938	211.22	High	High
Tullaghan	0.5% Coastal	6	Individual Property Protection	€ 105,431	€ 15,868	€ 23,690	0.67	169	7115.11	Moderate	Moderate

6 THE DEVELOPMENT OF THE UoM36 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 UoM36 there were four very low risk AFAs, namely Ballinamore, Ballyconnell, Bundoran and Tullaghan AFAs.

The draft plans (Volume I) are supported by the final core hazard and risk mapping 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 UoM36, 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 ether under the North Western Neagh Bann CFRAM Study:

- ***Ballybay Flood Relief Scheme: Option 1 - Hard defences***
- ***Cavan Flood Relief Scheme: Option 1 - Hard defences.***

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.

However, it should be noted that at all stages of CFRAM consultation there was extensive interest regarding rural property and access road flooding, particularly within the Erne system around County Cavan, with many landowners supporting drainage and maintenance works on the watercourses and requesting a cross-border investigation of such measures.

Another 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 between September and October 2016, at the following locations (Cavan, Monaghan and Donegal Town).

In addition to recording stakeholder comments, these events supported the formal consultation process by raising awareness of how submissions on the 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). The consultations and submissions on the draft FRMP provided valuable information, which has been noted for detailed design.

Within UoM36 the key development incorporated into the final plan resulted from re-assessment of a flood cell containing at WWTP in Cavan which yielded an improved benefit cost ratio.

The final FRMP measures for UoM36 are presented in Table 6.1.

Table 6.1 Summary of Flood Risk Management Measures – UoM36

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, D/HPCLG
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 within UoM36		
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.		
Ballybay	OPW and/or Monaghan County Council	OPW
Cavan	OPW and/or Cavan Council	OPW

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 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 the 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 suggests 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 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 UoM36 and across the North Western Neagh Bann CFRAM Study area. It has also provided sufficient clarity to allow, for the first time, a national prioritisation process to be undertaken for presentation in 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.

However, it should be noted that at all stages of North Western Neagh Bann CFRAM consultation there was extensive interest regarding rural property and access road flooding, particularly around County Cavan, with many landowners supporting drainage and maintenance works on the watercourses and requesting a cross-border investigation of such measures. These issues could not

be adequately addressed under the first CFRAM cycle and it is recommended that these are assessed further taking the wider damages and risks into account and possibly considering alternative standards of protection for such rural flooding issues.

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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2. S.I. No. 122/2010 - European Communities (Assessment and Management of Flood Risks) Regulations 2010
3. S.I. No. 495/2015 - European Communities (Assessment and Management of Flood Risks) (Amendment) Regulations 2015
4. National Flood Risk Assessment and Management Programme, Catchment-based Flood Risk Assessment and Management (CFRAM) Studies, Stage I Tender Documents: Project Brief, Office of Public Works, 2010
5. National Flood Risk Assessment and Management Programme, North Western Neagh Bann River Basin District Catchment-based Flood Risk Assessment and Management (CFRAM) Study, Stage II Tender Documents: Project Brief, Office of Public Works, 2011
6. North Western Neagh Bann CFRAM Study, HA36 Inception Report, IBE0700Rp0004 (RPS, 2012)
7. North Western Neagh Bann CFRAM Study, HA36 Hydrology Report, IBE0700Rp0009 (RPS, 2016)
8. North Western Neagh Bann CFRAM Study, HA36 Hydraulics Report, IBE0700Rp0010 (RPS, 2016)
9. North Western Neagh Bann CFRAM Study, UoM36 Preliminary Options Report, IBE0700Rp0019 (RPS, 2016)
10. North Western Neagh Bann CFRAM Study, UoM36 draft FRMP, IBE0700Rp0028 (RPS, 2016)

APPENDIX A

KEY INFORMATION UOM36

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 - The is a low level of uncertainty, an, 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 measures 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.