North Western Neagh Bann

CFRAM Study

Final Report

Unit of Management 06

DOCUMENT CONTROL SHEET

Client	The OPW					
Project Title	North Western Neagh Bann CFRAM Study					
Document Title	IBE0700Rp0052_ UoM06 Final Report_F02					
Document No.	IBE0700Rp0052					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No. of Appendices
	1	1	38	1	1	1

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
F01	First Version	Various	M Brian	G Glasgow	Belfast	Aug 2017
F02	2nd Version	Various	M Brian	G Glasgow	Belfast	Nov 2017

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

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 06

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 Neagh Bann IRBD covers an area of 8,120 km^2 with approximately 1,779 km^2 of that area in Ireland. It represents one single Unit of Management (UoM), UoM06 (Neagh Bann). This report covers only the portion of the Neagh Bann district within Ireland which includes the majority of County Louth, much of County Monaghan and significant areas of Meath and Cavan.

The principal Irish rivers in UoM06 are the Fane, Glyde and Dee rivers (which flow eastwards into the Irish Sea) and the Blackwater River (which flows over the border into Northern Ireland in the northern reaches of the UoM).

UoM06 is predominantly rural with the largest urban areas being Dundalk, Monaghan and Ardee. Smaller towns and villages include Castleblayney and Carrickmacross. Much of UoM06 is given over to agriculture with some areas of forestry and peatland cover.

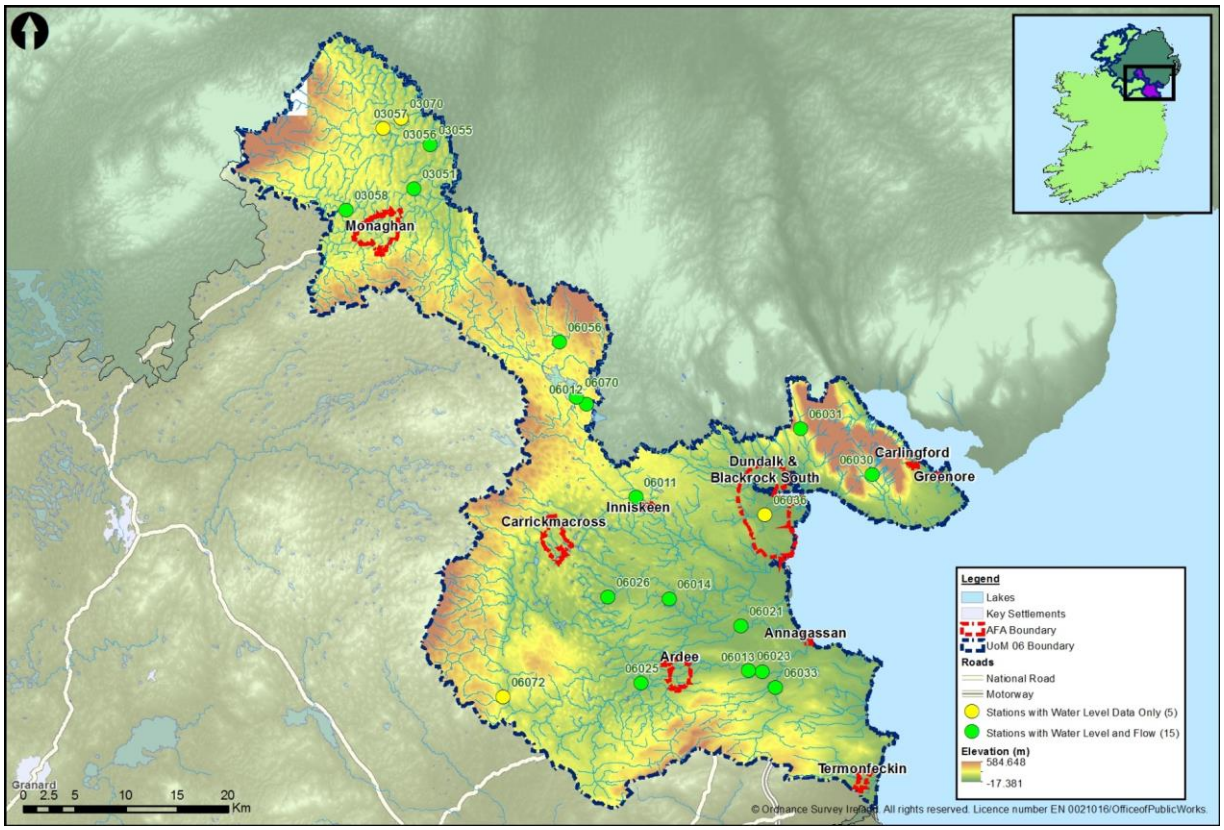

Figure 1.1: UoM06 Location Map

Within UoM06 the OPW has implemented and undertakes an annual programme to maintain the Glyde and Dee Arterial Drainage Scheme and the Blackwater Arterial Drainage Scheme which 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 much of the main channels and a large number of 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 have undoubtedly reduced the fluvial flood risk in certain parts of UoM06.

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 three Drainage Districts located within UoM06 (Blackwater DD, Fane DD and Wottanstown DD), two are located directly on 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).*

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 UoM06 as part of the North Western Neagh Bann CFRAM Study, and; detail the development of the draft UoM06 Flood Risk Management Plan (FRMP) which will be consulted on during the second half of 2016 and the finalisation of the UoM06 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 final report accompanies the draft UoM06 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 UoM06 technical reports on inception, hydrology, hydraulics and preliminary options. These reports are summarised in Sections 2 to 5 of this report respectively.

The development of the 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 & UoM06 Specific Reports

Ref.	Document Title
Rp0001	IBE0700Rp0001_Communications Plan, Implementation Programmes & Event Plans • Initial Scoping Phase • Mapping Phase • Options Phase • Draft Plan Phase
Rp0003	IBE0700Rp0003_HA06 Inception Report
Rp0005	IBE0700Rp0005_Stakeholders Workshop No 1 Summary Report
Rp0007	IBE0700Rp0007_HA01, HA06 & HA36 North West Neagh Bann Survey Contract Report
Rp0008	IBE0700Rp0008_UoM06 Hydrology Report
Rp0012	IBE0700Rp0012_UoM06 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
Rp0018	IBE0700Rp0018_UoM06 POR
Rp0021	IBE0700Rp0021_E_SEA_Environmental_Report_D01 UoM06
Rp0025	IBE0700Rp0025_UoM06_NIS
Rp0027	N06_FRMP_PART01
Rp0031	IBE0700Rp0031_UoM06_draft final report
Rp0032	IBE0700Rp0032_Option Phase Summary Report
Rp0034	IBE0700Rp0034 UoM06 Strategic SUDS Report
Rp0037	IBE0700Rp0037_UoM06 Strategic Planning Report
Rp0040	IBE0600Rp0040_UoM06_SEA_Environmental_Statement
Rp0043	IBE0600Rp0043_UoM06 Defence Asset Database Report
Rp0046	IBE0600Rp0046_UoM06_*NWNB CFRAM Study Preliminary Health & Safety Information*
Rp0050	N06_FRMP_PART01 Flood Risk Management Plan
Rp0052	IBE0600Rp0031_UoM06 Final Report (this report)
Rp0054	IBE0600Rp0054_Draft Plan Phase Synthesis Report
OPW	*UoM06 Consultation Synthesis report*

1.4 ACCOMPANYING AND SUPPORTING GIS DELIVERABLES

Table 1.2: List of GIS Deliverables – North Western Neagh Bann CFRAM Study Overall & UoM06 Specific

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 Datasets	**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, which has been reviewed by the PSDP and will be provided with the final project deliverables in 2017.

2 THE UoM06 INCEPTION REPORT

In 2012, an inception report was prepared for UoM06. Its principal objective was to provide detail on the relevant datasets identified for use in the Neagh Bann 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 report preparation, RPS had not identified any significant data gaps that would impact upon 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 UoM06 HYDROLOGY REPORT

In 2013, RPS commenced the preparation of the UoM06 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 UoM06.

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 estimation of design flows was based on a methodology combining the available best practice guidance for Irish catchments and hydrological catchment rainfall run-off modelling to supplement the available gauged data with simulated flow data. Best practice guidance for Irish catchments is contained within the Flood Studies Update and the statistical analysis of the data available from the hydrometric gauge stations was carried out based on the guidance contained within FSU Work Packages 2.1 ‘Hydrological Data Preparation’ and 2.2 ‘Flood Frequency Analysis’. The RPS methodology additionally used the historical time series meteorological data as an input to catchment scale hydrological rainfall run-off models to simulate a continuous flow records within a catchment thus supplementing existing flow data records.

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 UoM06 catchment can be characterised hydrologically as follows:

- The catchment has a wide range of climatic and physiographic characteristics. The drier, lowland areas in the Glyde and Dee floodplain have SAAR values as low as 762mm while catchments in the upland areas of Carlingford Mountain have SAAR values in excess of 1200mm.

- Hydrometric data is of good quality and availability for larger channels but is not available for 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, 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 1.9 to 3.5 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 catchment entering from Northern Ireland such as the Cor/ Blackwater catchment. However 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 seven stations with flow data available located on the modelled reaches within UoM06. Of these stations five were classified as having a good enough rating such that they were taken forward for use within the Flood Studies Update and four were deemed to have a rating classification of A1 suggesting high confidence at flood flows. 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 four out of nine 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 at proposed new locations and at the existing gauging stations. 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:

   - ***Ardee (Rathgory / Mullameelan watercourse)***
   - ***Carlingford (Carlingford watercourse and Carlingford Commons watercourse)***
   - ***Greenore (Mullatee and Millgrange watercourses)***
   - ***Carrickmacross (River Glyde)***
   - ***Dundalk (Greengates, Castletown and Accareagh watercourses)***
   - ***Monaghan (Monaghan River, Killygowan and Telaydan watercourses).***

   There is 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 Monaghan (03051 Faulkland and 03058 Cappog Bridge), Dundalk (06036 Ladyswell) and Annagassan (06021 Mansfieldtown) where existing stations could potentially be upgraded or improved through additional data collection such that they can be used with greater certainty in flood flow analysis. 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 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 UOM06 HYDRAULICS REPORT

Following delivery of UoM06 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.

UoM06 includes nine AFAs which has resulted in the development of nine separate models for flood risk analysis. A single model was developed for the Dundalk and Blackrock AFAs, due to their proximity and hydraulic interaction whilst the Carlingford/Greenore AFA was modelled as separate models as there is no 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.

For Termonfeckin AFA, the ISIS hydraulic modelling software package (developed by CH2M HILL) was 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.

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 – Annagassan, Dundalk/Blackrock within UoM06) 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 UoM06 in particular the 1%AEP fluvial (or 0.5%AEP coastal) design events are summarised as follows:

Annagassan - The model gives a satisfactory representation of the flood mechanisms described from the available flood event records and considered to be performing satisfactorily for design event simulation. Flooding is predicted in Annagassan due to both 0.5% AEP coastal events and 0.5% AEP wave overtopping events. During a 0.5% AEP coastal event inundation is predicted due to an unimpeded flow path through low lying ground via a gap in the wall along Harbour Road. There is also a low point along the embankment on the right bank of the River Glyde approximately 200m upstream from Annagassan Bridge. Flooding also is predicted during the 0.5% AEP wave overtopping events due to insufficient protection from existing defences. There are a number of residential and business properties which are at flood risk within Annagassan during the 0.5% AEP coastal events. A small number of local

roads and a regional road are also located within the floodplain.

Ardee - The limited information available has provided quantitative support for model results. There are two main locations at risk of fluvial flooding during a 1% AEP event in Ardee. One area is subject to flooding due to insufficient culvert capacity on the Mullameelan River. Out of bank flooding also is predicted along the Rathgory River due to insufficient culvert capacity. Downstream of this, there is a second area at risk where insufficient culvert capacity in the Mullameelan River again causes flooding. Raised water levels along the Mullameelan result in water backing up Rathgory Tributary 1. Out of bank flooding is predicted. These locations of flooding may interact with one another. There are a number of residential and business properties at risk in Ardee with local urban roads and a couple of main roads also located within the floodplains.

Carlingford/Greenore - The model is considered to be performing satisfactorily for design event simulation. Carlingford and Greenore are affected by flooding from 0.5% AEP coastal, 0.5% AEP wave overtopping and 1% AEP fluvial flood events. There are a number of different locations where receptors are at risk. One area is affected by both 0.5% AEP coastal, 0.5% AEP wave overtopping events. Tidal inundation and wave overtopping would occur at Carlingford Harbour along the quays and adjacent to the Ghan Road to the east of the AFA. In a separate discrete area, flooding is predicted in the Greenore AFA during a 0.5% tidally dominant flood event and also during a 1% AEP fluvial flood event. There are a number of other locations which are affected by 1% AEP fluvial events. The Carlingford Commons watercourse flows into Carlingford AFA from the steep catchment of Carlingford Mountain. Low bank levels cause out of bank flooding whilst culverts with insufficient capacity to convey flood waters. This causes two locations of flooding which interact due to their close proximity. There is another discrete area of flooding where the Mullatee watercourse flows through the Greenore AFA. A culvert upstream does not have sufficient capacity to convey flood waters which results in out of bank flooding in the area. There are a significant number of both residential and business properties at risk of flooding within the Carlingford and Greenore AFAs (also including cultural heritage assets and social amenities such as Surgery/Health Centre and a Community Centre). A small number of regional roads are also situated within the floodplain. As a result there are significant damages and risks in present day and future scenarios.

Carrickmacross - Despite the lack of calibration and verification data, the model is considered to be performing satisfactorily for design event simulation. Carrickmacross is affected by fluvial flooding during a 1% AEP event. There are two locations in close proximity which can interact. At one area the floodplain is inundated due to insufficient culvert capacity on the River Glyde. A further location downstream is affected due to raised water levels in the Glyde leading to out of bank flooding. In a discrete location during the 1% AEP flood event, the flow discharging into the lake from Tullynaskeagh River and Kilmactrasna Tributary 2 would be

sufficiently high to cause water back up resulting in out of bank flooding. There are a number of properties both residential and non-residential at risk of flooding during a 1% AEP fluvial event. A couple of social amenities and cultural heritage assets are also at risk along with a regional road. Carrickmacross AFA is considered to be at very low risk during the present day 1% AEP fluvial event.

Dundalk and Blackrock South - There is good confidence in the hydrological and hydraulic analysis of the Dundalk and Blackrock South AFA. There is extensive historical flood information available (including photographs and flood outlines) for a verification exercise of the Dundalk and Blackrock model, with the model comparing well with the vast majority of evidence. It should be noted that as there are no active gauging stations with available flow data within the model extent, full fluvial model calibration was not possible. The 2D coastal domain of the model has been calibrated well using Admiralty tidal information. Dundalk and Blackrock South are affected by flooding from 0.5% AEP coastal, 0.5% AEP wave overtopping and 1% AEP fluvial flood events. There are a large number of different locations where receptors are at risk. There are a small number of locations situated in the south of the AFA which flood due to coastal inundation. As they are in close proximity they can interact. There are another few locations to the north of this which are also in close proximity and are affected by a combination of wave overtopping and tidal inundation. In an area to the south east of the AFA a flood defence wall is outflanked to the north during a 0.5% tidal event and also overtopped during a 0.5% wave event, affecting a large number of properties. Further, there is a large area to the east of the AFA which is affected by both 0.5% tidal and 1% fluvial flood mechanisms. The area features existing embankments and defence walls to the east and north respectively. The breach of these defences puts a large number of properties at risk of flooding. Further, there are five discrete locations affected by fluvial flooding during a 1% AEP event. One of these events is in the south east of the AFA whilst the others are located further north. These locations of flooding are largely due to insufficient culvert capacity which leads to out of bank flooding. There are also a small number of locations affected by fluvial flooding. Two other locations which are impacted by fluvial flooding have complicated flood mechanisms involved. There are a substantial number of both residential and business properties which are at flood risk within Dundalk and Blackrock South. High numbers of receptors including social amenity sites and transport infrastructural assets are also located within these floodplains. As a result there are significant damages and risks in the AFA for present day and future scenarios.

Inniskeen - There is good confidence in both the hydrology and hydraulics of the Inniskeen AFA due to the presence of a gauging station at Moyles Mill (06011) and flood extent verification events. Inniskeen is affected by fluvial flooding during a 1% AEP event. In one location the Lannat River adjoins with the Fane River and during flood events high water levels in the Fane causes a backwater affect along the lower reaches of the Lannat. The combination

of relatively low bank levels and the presence of a critical structure contribute to flooding on both the left and right banks of both watercourses. Further, another area of flooding is located downstream of this. Here several small tributaries connect with the River Fane. Flood waters that have originated upstream and flowed across Inniskeen Town Park contribute to flooding, with insufficient channel capacity being the main cause. This area has several flooding sources within it. There are a number of residential and non-residential properties at risk along with an electricity hereditament and a couple of local roads.

Monaghan - There is good confidence in both the hydrology and hydraulics of the Monaghan AFA/HPW due to the presence of a gauging station. The model is validated by the most recent flood events and is confirmed with aerial photos and comment received during the local authority workshop. Monaghan is affected by fluvial flooding during a 1% AEP event in a number of different locations within the AFA. There are three locations of discrete flooding, one in the south and two in the east. These locations are mainly at risk due to insufficient capacity of critical structures causing out of bank flooding. There are a couple of instances where flooding is predicted in locations which are in close proximity and can therefore interact. In one area high water levels in the Cor River propagate up the Monaghan River causing back water effects and putting properties at risk of flooding. Here insufficient capacity of critical structures also results in flooding. There are two interacting locations with a number of rivers contributing to the flood risk, back flow affects from the Cor River, and insufficient culvert capacity. There are a number of residential and business properties at risk of flooding within Monaghan AFA including social infrastructure assets. Many roads are also located within the floodplains including five national roads, a couple of regional roads and some local roads.

Termonfeckin - Despite the lack of fluvial calibration data, the model is considered to be performing satisfactorily for design event simulation. Termonfeckin is affected by both 1% AEP fluvial and 0.5% AEP coastal flood events; however there are no receptors subject to coastal risk up to and including the 0.5% AEP event. There are two discrete locations at risk of flooding, one of which is subject to out of bank flooding due to insufficient channel capacity caused by a weir structure. Downstream of this on the Termonfeckin watercourse flooding is predicted due to low bank levels and high water levels again associated with insufficient channel capacity. This instance is exacerbated by a restriction of flow associated with bridge structures. There are a small number of residential and business properties at risk of flooding within Termonfeckin along with a couple of regional and local roads.

5 THE UoM06 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 UoM06 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 Carrickmacross AFA, a Public Consultation Day was 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 queries and suggested measures relevant to Dundalk 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 Navan, 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 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 potential proposed options.

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 UoM06 respectively.

Table 5.1 Flood Risk Analysis UoM06

(Fluvial statistics unless otherwise stated; Coastal 1 = Coastal / Tidal Flooding; Coastal 2 = Wave Overtopping Flooding)

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event							
	Annagassan	Ardee	Carlingford/ Greenore	Carrickmacross	Dundalk & Blackrock South	Inniskeen	Monaghan	Termonfeckin
Current Scenario								
Event Damage (€)	0 Fluvial 1,353,735 Coastal 1 2,550,195 Coastal 2	4,525,438	27,086,224 Fluvial 12,635,904 Coastal 1 3,361,849 Coastal 2	271,757	27,694,989 Fluvial 117,017,514 Coastal 1 16,743,463 Coastal 2	1,246,179	15,928,570	624,068 Fluvial 0 Coastal 1
No. Residential Properties at Risk	0 Fluvial 9 Coastal 1 17 Coastal 2	6	136 Fluvial 117 Coastal 1 59 Coastal 2	7	420 Fluvial 1233 Coastal 1 52 Coastal 2	10	13	5 Fluvial 0 Coastal 1
No. Business Properties at Risk	0 Fluvial 4 Coastal 1 4 Coastal 2	1	54 Fluvial 34 Coastal 1 9 Coastal 2	3	23 Fluvial 119 Coastal 1 33 Coastal 2	4	34	2 Fluvial 0 Coastal 1
No. Utilities at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	2 Fluvial 4 Coastal 1 0 Coastal 2	1	0	0 Fluvial 0 Coastal 1
No. Major Transport Assets at Risk	1 Fluvial 1 Coastal 1 2 Coastal 2	3	32 Fluvial 32 Coastal 15 Coastal 2	8	54 Fluvial 88 Coastal 1 4 Coastal 2	3	16	3 Fluvial 0 Coastal 1

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event							
	Annagassan	Ardee	Carlingford/ Greenore	Carrickmacross	Dundalk & Blackrock South	Inniskeen	Monaghan	Termonfeckin
No. Highly Vulnerable Properties at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 1 Coastal 1 0 Coastal 2	2	1	0 Fluvial 0 Coastal 1
No. of Social Infrastructure Assets at Risk	2 Fluvial 5 Coastal 1 2 Coastal 2	10	36 Fluvial 24 Coastal 1 8 Coastal 2	8	42 Fluvial 68 Coastal 1 2 Coastal 2	3	44	1 Fluvial 0 Coastal 1
No. Environmental Assets at Risk	3 Fluvial 3 Coastal 1 3 Coastal 2	3	5 Fluvial 4 Coastal 1 4 Coastal 2	2	11 Fluvial 10 Coastal 1 5 Coastal 2	2	4	6 Fluvial 4 Coastal 1
No. Potential Pollution Sources at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0	0 Fluvial 0 Coastal 1
Mid-Range Future Scenario								
Event Damage (€)	665,190 Fluvial 17,595,322 Coastal 1 7,147,410 Coastal 2	6,159,292	48,187,384 Fluvial 56,371,306 Coastal 1 30,744,860 Coastal 2	2,279,010	109,839,173 Fluvial 1,009,516,937 Coastal 1 28,041,340 Coastal 2	3,865,505	63,999,510	2,020,873 Fluvial 0 Coastal 1
No. Residential Properties at Risk	1 Fluvial 68 Coastal 1 42 Coastal 2	20	263 Fluvial 320 Coastal 1 219 Coastal 2	24	1388 Fluvial 6254 Coastal 1 81 Coastal 2	18	61	11 Fluvial 0 Coastal 1

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event							
	Annagassan	Ardee	Carlingford/ Greenore	Carrickmacross	Dundalk & Blackrock South	Inniskeen	Monaghan	Termonfeckin
No. Business Properties at Risk	2 Fluvial 12 Coastal 1 10 Coastal 2	7	64 Fluvial 59 Coastal 1 20 Coastal 2	9	117 Fluvial 432 Coastal 1 36 Coastal 2	16	66	3 Fluvial 0 Coastal 1
No. Utilities at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	4 Fluvial 5 Coastal 1 0 Coastal 2	2	0	0 Fluvial 0 Coastal 1
No. Major Transport Assets at Risk	2 Fluvial 6 Coastal 5 Coastal 2	10	42 Fluvial 38 Coastal 1 21 Coastal 2	13	151 Fluvial 272 Coastal 1 8 Coastal 2	4	42	3 Fluvial 0 Coastal
No. Highly Vulnerable Properties at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	2 Fluvial 13 Coastal 1 0 Coastal 2	2	3	0 Fluvial 0 Coastal 1
No. of Social Infrastructure Assets at Risk	3 Fluvial 7 Coastal 1 7 Coastal 2	11	40 Fluvial 38 Coastal 1 12 Coastal 2	9	67 Fluvial 173 Coastal 1 3 Coastal 2	4	51	4 Fluvial 0 Coastal 1
No. Environmental Assets at Risk	3 Fluvial 3 Coastal 1 3 Coastal 2	3	5 Fluvial 4 Coastal 1 4 Coastal 2	2	11 Fluvial 10 Coastal 1 5 Coastal 2	2	4	6 Fluvial 4 Coastal 1
No. Potential Pollution Sources at Risk	3 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0	0 Fluvial 0 Coastal 1

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event							
	Annagassan	Ardee	Carlingford/ Greenore	Carrickmacross	Dundalk & Blackrock South	Inniskeen	Monaghan	Termonfeckin
High End Future Scenario								
Event Damage (€)	7,305,306 Fluvial 26,227,721 Coastal 1 14,425,537 Coastal 2	8,461,129	63,903,024 Fluvial 69,656,693 Coastal 1 50,042,136 Coastal 2	13,420,667	661,381,617 Fluvial 1,486,773,793 Coastal 1 63,597,921 Coastal 2	5,214,030	90,306,176	2,541,852 Fluvial 0 Coastal 1
No. Residential Properties at Risk	46 Fluvial 97 Coastal 1 87 Coastal 2	41	393 Fluvial 347 Coastal 1 268 Coastal 2	107	5606 Fluvial 7697 Coastal 1 379 Coastal 2	23	99	12 Fluvial 0 Coastal 1
No. Business Properties at Risk	7 Fluvial 14 Coastal 1 10 Coastal 2	8	67 Fluvial 62 Coastal 1 29 Coastal 2	16	358 Fluvial 566 Coastal 1 45 Coastal 2	18	82	3 Fluvial 0 Coastal 1
No. Utilities at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 1 Coastal 1 0 Coastal 2	0	6 Fluvial 8 Coastal 1 0 Coastal 2	2	1	1 Fluvial 0 Coastal 1
No. Major Transport Assets at Risk	7 Fluvial 7 Coastal 1 7 Coastal 2	13	43 Fluvial 38 Coastal 23 Coastal 2	23	279 Fluvial 350 Coastal 1 21 Coastal 2	4	55	6 Fluvial 2 Coastal
No. Highly Vulnerable Properties at Risk	0 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	7 Fluvial 27 Coastal 1 2 Coastal 2	2	3	0 Fluvial 0 Coastal 1

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event							
	Annagassan	Ardee	Carlingford/ Greenore	Carrickmacross	Dundalk & Blackrock South	Inniskeen	Monaghan	Termonfeckin
No. of Social Infrastructure Assets at Risk	7 Fluvial 7 Coastal 1 7 Coastal 2	13	41 Fluvial 44 Coastal 1 13 Coastal 2	9	144 Fluvial 210 Coastal 1 9 Coastal 2	6	55	7 Fluvial 0 Coastal 1
No. Environmental Assets at Risk	3 Fluvial 3 Coastal 1 3 Coastal 2	3	5 Fluvial 4 Coastal 1 4 Coastal 2	2	11 Fluvial 10 Coastal 1 5 Coastal 2	2	4	6 Fluvial 4 Coastal 1
No. Potential Pollution Sources at Risk	3 Fluvial 0 Coastal 1 0 Coastal 2	0	0 Fluvial 0 Coastal 1 0 Coastal 2	0	1 Fluvial 3 Coastal 1 0 Coastal 2	0	0	0 Fluvial 0 Coastal 1

Table 5.2 Potential Options UoM06

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
UoM06	-	-	Sustainable Planning and Development Management Public Awareness Campaign	-	-	-	-	-	-	-	-
Annagassan	1% Fluvial	30	Hard Defences	€6,598,463	€3,128,506	3.7	0.85	919	248.343	High	High
Ardee	1% Fluvial	7	Option 1 - Hard Defences	€12,957,910	€2,662,064	0.84	3.16	738	875.19	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
			Option 2 - Hard Defences & Storage			1.1	2.44	480	430.3		
Carlingford & Greenore	1% Fluvial 0.5% Coastal	296	Hard Defences, Improved Channel Conveyance and 2 Pumping Stations	€ 231,729,291	€63,119,180	23.41	2.7	1329	56.8	High	High
Carrickmacross	1% Fluvial	10	Land Use Management	€496,900	€105,566	-	-	-	-	Moderate	Moderate
Dundalk & Blackrock South	1% Fluvial 0.5% Coastal	1737	Option 1 - Hard Defences, Improvement of Channel Conveyance, Storage (Ver 1)	€258,771,933	€134,940,954	39.43	3.42	1004	25.47	High	High

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
			Option 2 - Hard Defences, Improvement of Channel Conveyance, Storage (Ver 2)			40.54	3.33	1134	27.98		
			Option 3 - Hard Defences, Improvement of Channel Conveyance, Storage, Relocation of Properties (Ver 1)			39.47	3.42	1620	41.05		
			Option 4 - Hard Defences, Improvement of Channel Conveyance, Storage, Relocation of Properties (Ver 2)			40.58	3.33	1540	37.96		

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
Inniskeen	1% Fluvial	14	Option 1 - Hard Defences	€5,916,598	€2,669,275	2.1	1.27	1049	499.9	Low	Moderate
			Option 2 – Hard Defences and Improved Channel Conveyance			3.93	0.68	667	169.6		
			Option 3 – Hard Defences and Improved Channel Conveyance			2.13	1.25	1049	192.82		
Monaghan	1% Fluvial	47	Option 1 - Hard Defences (Ver 1) and Other Works	€26,948,607	€12,611,668	12.5	1	954	76.3	High	High
			Option 2 - Hard Defences (Ver 2) and Other Works			13.6	0.93	1099	81		

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
Termonfeckin	1% Fluvial	7	Option 1 - Improved Channel Conveyance	€682,863	€319,080	0.35	0.90	-289	-815.3	Moderate	Moderate
			Option 2 - Hard Defences and Improved Channel Conveyance			0.62	0.51	-145	-232.1		

6 THE DEVELOPMENT OF THE UOM06 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 UoM06 there was one very low risk AFAs, namely Carrickmacross AFA.

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 UoM06, 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:

- ***Annagassan Flood Relief Scheme: Option 1 - Hard defences***
- ***Ardee Flood Relief Scheme: Option 1 - Hard defences***
- ***Carlingford and Greenore Flood Relief Scheme: Option 1 - Fluvial & Coastal Hard Defences, Improved Channel Conveyance and 2 Pumping Stations***
- ***Dundalk and Blackrock South Flood Relief Scheme: Option 2 - Hard Defences, Improvement of Channel Conveyance, Storage or Option 4 - Hard Defences, Improvement of Channel Conveyance, Storage, Relocation of Properties.***
- ***Inniskeen Flood Relief Scheme: Option 1 - Hard Defences***

- ***Monaghan Flood Relief Scheme: Option 1 - Hard Defences Version 1 and Other Works***
- ***Termonfeckin Flood Relief Scheme: Option 1 - 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 between August and October 2016, at the following locations (Monaghan Town, Carrickmacross, Dundalk and Drogheda).

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 such as is the case for Dundalk and Blackrock there is potential for residual environmental impact which necessitates further study meaning that two options are detailed in the final plan). The consultations and submissions on the draft FRMP provided valuable information, which has been noted for detailed design.

A submission from Monaghan County Council changed the selection of the preferred measure for the AFA, as a scheme, independent of the CFRAM process, to protect the road junction in the town centre is currently progressing.

The final FRMP measures for UoM06 are presented in Table 6.1.

Table 6.1 Summary of Flood Risk Management Measures – UoM06

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.		
Ardee	OPW and/or Louth CoCo - To be confirmed	OPW
Carlingford and Greenore	OPW and/or Louth CoCo - To be confirmed	OPW
Dundalk and Blackrock South	OPW and/or Louth CoCo - To be confirmed	OPW
Inniskeen	OPW and/or Monaghan CoCo - To be confirmed	OPW
Monaghan	OPW and/or Monaghan CoCo - To be confirmed	OPW
Undertake a Detailed Assessment of the Costs of the Potential Measure for the Communities set out below.		
Annagassan	OPW and/or Louth CoCo - To be confirmed	OPW
Termonfeckin	Typically the local authority (Louth CoCo) 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 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 Carrickmacross area) 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 UoM06 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 and will provide 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

1. EC Directive on the Assessment and Management of Flood Risks (2007/60/EC)
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, HA06 Inception Report, IBE0700Rp0003 (RPS, 2012)
7. North Western Neagh Bann CFRAM Study, HA06 Hydrology Report, IBE0700Rp0008 (RPS, 2016)
8. North Western Neagh Bann CFRAM Study, HA06 Hydraulics Report, IBE0700Rp0012 (RPS, 2016)
9. North Western Neagh Bann CFRAM Study, UoM06 Preliminary Options Report, IBE0700Rp0018 (RPS, 2016)
10. North Western Neagh Bann CFRAM Study, UoM06 draft FRMP, IBE0700Rp0027 (RPS, 2016)

APPENDIX A

KEY INFORMATION UOM06

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.