



# Eastern CFRAM Study

## Final Report

### Unit of Management 07

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## ABBREVIATIONS

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

# 1 INTRODUCTION

## 1.1 UNIT OF MANAGEMENT 07

The Eastern CFRAM Study covers an area of approximately 6,250 km<sup>2</sup> and includes four River Basins or Units of Management (UoMs); UoM07 (Boyne), UoM08 (Nanny – Delvin), UoM09 (Liffey-Dublin Bay) and UoM10 (Avoca-Vartry).

There is a high level of flood risk within some locations in UoM07 with significant coastal and fluvial flooding events having occurred in the past. UoM07, shown in Figure 1.1, covers an area of approximately 2,695 km<sup>2</sup> and includes parts of counties Louth, Cavan, Meath, Westmeath, Offaly, and Kildare. UoM07 is a predominantly rural catchment, but with major urbanised areas such as Drogheda and Navan as well as a number of smaller settlements.

There are two principal rivers within UoM07, the River Boyne which rises in the south west of the area and flows north eastwards through Trim and Navan to its estuary at Drogheda, and the River Blackwater, which rises in the north west of the area and joins the Boyne in Navan. Other significant rivers within UoM07 are the Skane River, River Deel, Stonyford River, Athboy/Tremblestown River and a second Blackwater River in Co Kildare.

Within UoM07 the OPW has implemented and maintains the Boyne Arterial Drainage Scheme which was undertaken by the OPW between 1967 and the mid-1980's, under the 1945 Arterial Drainage Act. The OPW continues to have statutory responsibility for inspection and maintenance of the Scheme, which includes much of the main Boyne channel 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 UoM07.

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 six Drainage Districts located within UoM07, none are located directly on the key watercourses where fluvial and coastal flood risk is being considered within Ireland's first cycle assessment under the Floods Directive.

The main channel of the Boyne River from Drogheda, downstream to the mouth of the estuary is maintained by Drogheda Port Company. As this maintenance regime results in increased channel capacity it is considered to result in a decrease in fluvial flood risk. Flood risk would be likely to increase if these existing maintenance activities were discontinued.

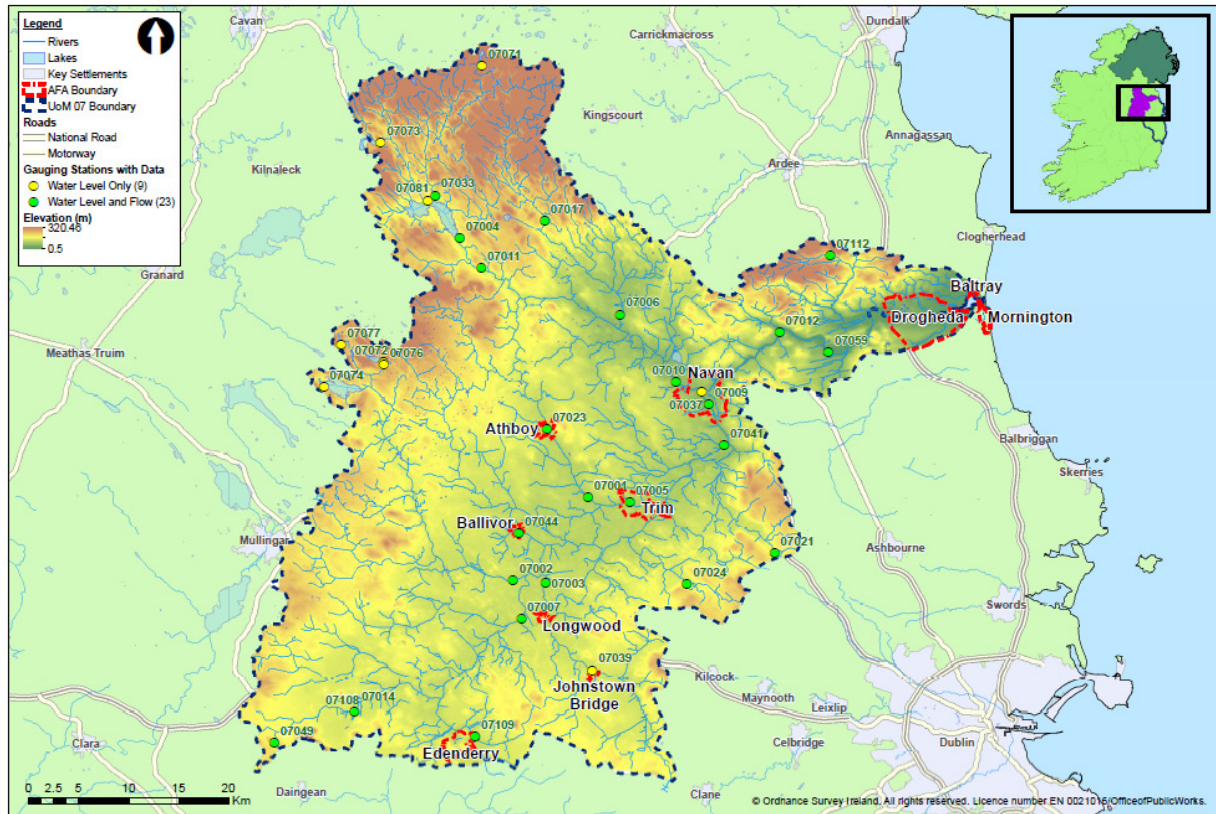


Figure 1.1: UoM07 Location Map

## 1.2 OBJECTIVE OF THIS REPORT

The principal objective of this final report, in accordance with Section 12.2 of the CFRAM Studies Stage 1 Project Brief, is to; provide a summary of the relevant reports prepared for UoM07 as part of the Eastern CFRAM Study, and; detail the development of the UoM07 Flood Risk Management Plan (FRMP) - consulted on during the second half of 2016 and the finalisation of the UoM07 FRMP in preparation for its adoption in 2017.

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

### 1.3 ACCOMPANYING AND SUPPORTING REPORTS

This report accompanies the UoM07 Flood Risk Management Plan containing the following volumes:

- VOLUME I 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 UoM07 technical reports on inception, hydrology, hydraulics and preliminary options, which are summarised in Sections 2 to 5 of this report respectively.

The development of the Flood Risk Management Plan (FRMP) is summarised in Section 6 of this report.

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

**Table 1.1: List of Reports – Eastern CFRAM Study Overall & UoM07 Specific Reports**

Ref.	Document Title
Rp0001	IBE0600Rp0001_Flood Risk Review
Rp0002	IBE0600Rp0002_Communications Plan, Implementation Programmes & Event Plans <ul style="list-style-type: none"> <li>• Initial Scoping Phase</li> <li>• Mapping Phase</li> <li>• Options Phase</li> <li>• Draft Plan Phase</li> </ul>
Rp0003	IBE0600Rp0003_Potential Flood Risk to Environmental Receptors
Rp0004	IBE0600Rp0004_HA07 Inception Report
Rp0009	IBE0600Rp0009_Initial Scoping Phase Synthesis Report Stakeholders Workshop
Rp0011	IBE0600Rp0011_Initial Scoping Phase Synthesis Report Public Open Evening
Rp0012	IBE0600Rp0012_HA07 Hydrology Report
Rp0013	IBE0600Rp0013 Athboy Radar Analysis Trial
Rp0014	IBE0600Rp0014_Overarching Report on the October 2011 Flood Event
Rp0015	IBE0600Rp0015_Analysis of the Dublin Radar Data - Eastern CFRAM Study Area
Rp0017	IBE0600Rp0017 Review: FEM FRAM, Dodder & Tolka Studies
Rp0018	IBE0600Rp0018_HA07 Boyne Survey Contract Report
Rp0023	IBE0600Rp0023_Culvert blockage analysis
Rp0025	IBE0600Rp0025_HA07 Hydraulics Report
Rp0033	IBE0600Rp0033_Mapping Phase Synthesis Report
Rp0034	IBE0600Rp0034_E_SEA_Scoping_Report
Rp0035	IBE0600Rp0035_E_SEA_Constraints_Report
Rp0036	IBE0600Rp0036_Eastern_HDA_Screening
Rp0037	IBE0600Rp0037_UoM07 Preliminary Options Report (POR)

<b>Ref.</b>	<b>Document Title</b>
Rp0040	IBE0600Rp0040_E_SEA_Environmental_Report UoM07
Rp0042	IBE0600Rp0042_UoM07_NIS
Rp0044	IBE0600Rp0044 Review: FEM FRAM, Dodder & Tolka Studies Phases 2 & 3
Rp0047	E07_FRMP_PART01 draft Flood Risk Management Plan
Rp0051	IBE0600Rp0051_UoM07 Draft final report
Rp0055	IBE0600Rp0055_Option Phase Synthesis Report
Rp0056	IBE0600Rp0056_UoM07 Strategic SUDS Report
Rp0059	IBE0600Rp0059_UoM07 Strategic Planning Report
<i>Rp0062</i>	<i>IBE0600Rp0062_UoM07 Defence Asset Database Report</i>
<i>Rp0065</i>	<i>IBE0600Rp0065_UoM07 Eastern CFRAM Study Preliminary Health &amp; Safety Information</i>
<i>Rp0068</i>	<i>IBE0600Rp0068_E_SEA_Environmental_Statement UoM07</i>
<i>Rp0072</i>	<i>E07_FRMP_PART01 Flood Risk Management Plan</i>
<i>Rp0076</i>	<i>IBE0600Rp0076_UoM07 Final report (this report)</i>
Rp0080	IBE0600Rp0080_Draft Plan Phase Synthesis Report
<i>OPW</i>	<i>UoM07 Consultation Synthesis report</i>



## 1.4 ACCOMPANYING AND SUPPORTING GIS DELIVERABLES

**Table 1.2: List of GIS Deliverables – Eastern CFRAM Study Overall & UoM07 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	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 an Eastern CFRAM Study Preliminary Health & Safety Information which has been reviewed by the PSDP and will be provided with the final project deliverables in 2017.

## 2 THE UoM07 INCEPTION REPORT

In late 2011/early 2012, an inception report was prepared for UoM07. Its principal objective was to provide detail on the relevant datasets identified for use in UoM07 as part of the Eastern CFRAM Study, and also provide an update on the data collection and interpretation process at that stage.

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.

At the time of preparing the report RPS had not identified any significant data gaps that would impact on the completion of the Eastern CFRAM Study however this statement was made without having received complete coverage of 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 Eastern 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 Eastern CFRAM Study.***

Throughout the Eastern 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 UoM07 HYDROLOGY REPORT

In 2012, RPS commenced the preparation of the UoM07 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 UoM07.

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 UoM07 catchment can be characterised hydrologically as follows:

- The catchment has a fair range of climatic and physiographic characteristics. It is relatively 'dry' compared to other Irish catchments with Standard Annual Average Runoff values ranging from 650mm to 1100mm.

- There is good meteorological and hydrometric observation data 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 (Flood Studies Report - FSR). This is in line with other more recent, catchment specific studies such as the Greater Dublin Strategic Drainage Strategy or Fingal East Meath FRAMS.
- The 1% Annual Exceedance Probability (AEP) flood event ranges from approximately 2 (Boyne main channel) to 3.4 times larger than the median flood flow. This compares to approximately 2 under FSR.
- There is evidence that the arterial drainage scheme has increased the median flood flow by approximately 50%.

**Key Findings:**

***The primary output of the hydrological analysis was a design flow dataset, which was based on historical data and best practice estimation/modelling 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 through complementing statistical analysis techniques with rainfall run-off modelling that the design flow estimation has as high a degree of certainty as is possible prior to calibration/validation and that this 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 catchment specific uncertainty in the hydrological analysis (over and above standard statistical error in the estimation techniques) is due to the arterial drainage scheme and the fluctuating drainage characteristics of the catchment over its record period. As discussed, this risk has been mitigated through the use of the post arterial drainage dataset for design flow estimation which is considered to be more robust, and more reflective of the present day scenario. One added benefit of the catchment rainfall run-off modelling is that a simulated record can be produced that reflects the present day catchment more accurately. After this cycle of the Eastern 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. The population projections could translate into a rapid urbanisation of parts of the catchment and the potential for this to increase flood risk is obvious, particularly considering recent flood events, if this leads to development which is unsustainable from a drainage perspective. Sustainable development planning is key in mitigating this future risk, this is particularly considered in the Flood Risk Management Plan of***

**measures, such as, limiting post development run-off rates to greenfield rates 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 Eastern CFRAM Study were identified:**

- 1. All but one of the models have a gauging station within the modelled reaches, however, there are still many small, ungauged, tributaries affecting AFAs. 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. Recommendations were provided within the Plan to improve the availability of flood flow data at the existing gauging stations located within/upstream/downstream of AFAs and at key proposed new locations. Existing stations at Athboy, Ballivor, Edenderry, Johnstown Bridge and Navan could be upgraded to flood flow rated stations and the existing records utilised for the analysis of extreme floods, with new gauging stations recommended at Drogheda (Ushers Stream) and Mornington (Mornington River).**

**Interim improvements to the existing hydrometric gauge network should focus on improving the ratings through the collection of additional spot flow gaugings at flood flows and further development of the ratings at gauging stations near AFAs. Seven hydrometric gauging stations had rating review carried out, improving flow estimation. Hydraulic models/surveys, available from the Eastern CFRAM Study, could be used to review a further eight. All other stations on modelled watercourses could also benefit from rating review, to bring confidence to future extreme flood flow measurement or to estimate historic flows at gauging stations which are currently water level only.**

- 2. The rainfall run-off modelling carried out as part of this study has, due to programme and data constraints, been carried out following hydrological analysis of the gauge station data. The run-off modelling has effectively created a layer of additional simulated historic gauge station years for all of the gauge stations. This data has been utilised in the design flow estimation but could potentially be used to provide further statistical confidence to estimates of historic flood frequency or may even be used to inform hydrograph shape generation for ungauged, upland catchments in future studies.**
- 3. The Mornington River catchment is currently within Hydrometric Area 08 according to the EPA's River Basin District boundaries however a detailed study entitled 'Mornington District Surface Water & Flood Protection Scheme' (KMM, January 2004) identifies the main outfall point for the Mornington River catchment to be within the Boyne Estuary. In light of this, it is recommended that from this point forward the Mornington River catchment is considered to be part of HA07 and the OPW/EPA boundaries re-drawn taking into account catchment delineation completed as part of this study.**

## 4 THE UoM07 HYDRAULICS REPORT

Following delivery of UoM07 survey data in 2012, RPS undertook development of hydraulic models and hazard mapping throughout 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.

UoM07 includes ten AFAs which has resulted in the development of eight separate models for flood risk analysis. A single model was developed for the Drogheda, Baltray and Mornington AFAs, due to their proximity and hydraulic interaction.

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

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

For the Drogheda, Baltray & Mornington model, an integrated catchment modelling approach was chosen using InfoWorks ICM. This software provides a single platform to incorporate both urban and river catchments using fully integrated 1D and 2D hydrodynamic simulation techniques. Tidal boundaries are applied to both 1D and 2D model domains to incorporate tidal inundation where appropriate.

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) 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 UoM07, in particular the 1%AEP fluvial design event, are summarised as follows:***

***Athboy - The model was calibrated to the available spot gaugings at Athboy Town gauging station and the roughness values of the model adjusted accordingly, however, there is little quantitative data available to calibrate the Athboy model to the larger flood events and further observations would be necessary to reduce uncertainty in model results. Fluvial flooding is predicted, during the 1% AEP event, affecting a local road upstream of properties within Athboy AFA; there are no properties at flood risk during this event.***

***Ballivor – Again, the Ballivor model was calibrated to the available spot gaugings at Ballivor gauging station and the roughness values of the model adjusted accordingly. Limited verification was achieved whereby the areas shown to flood by the model are reported to have historically flooded, however, there is little or poor data to calibrate the model to and observation of more events would be necessary to reduce the uncertainty in model results. Fluvial flooding is predicted during the 1% AEP event within the AFA from Ballivor River with a small number of local roads in the floodplain affected. There is no risk to residential or non-***



***residential properties during this flood event.***

***Baltray - There is good confidence in both the hydrology and hydraulics of the Baltray AFA. The Baltray AFA is at risk from flooding by both fluvial and coastal mechanisms. All locations predicted to be affected by fluvial flooding are affected by coastal flooding to at least an equal severity.***

***Drogheda - There is good confidence in both the hydrology and hydraulics of the Drogheda AFA, particularly along the Boyne channel where there are high quality long term gauging station records and good flood extent verification events. Maintenance carried out by Drogheda Port Company on the main channel of the Boyne (largely dredging works) forms a significant part of the ongoing regime. The main predicted flood risk within Drogheda AFA is to receptors adjacent to the channel of the River Boyne due to high coastal and/or fluvial water levels. Coastal and fluvial flood mechanisms operate in tandem and the flood extents from both mechanisms overlap to some degree. The downstream portion of the Ushers Stream is affected both by culvert capacity and by tidal levels in the Boyne causing the discharge in the culvert to back up. There are two other locations of fluvially dominated flooding further upstream on this tributary watercourse. Two further discrete fluvially affected areas, each with few properties at risk are located on smaller tributaries within Drogheda AFA.***

***Edenderry - The gauging station data was found to be of limited use in verification of the Edenderry model due to its limited data availability. Therefore despite available information, including feedback from Local Authority review, confirming that the model represents the historical information well, a low confidence was assigned. Fluvial flooding is predicted during the 1% AEP event and a local road which crosses Weavers Drain is within the floodplain. There are no properties at risk during this event.***

***Johnstown Bridge - The model was calibrated to the spot gaugings at Castlerickard gauging station. However, lack of historical flooding information means that larger flood events should be recorded at the gauging station in order to improve model confidence. Fluvial flooding is predicted during the 1% AEP event at two discrete locations within the AFA. At each location there are a couple of properties within the floodplain affected due to the insufficient channel capacity of a tributary of the River Blackwater, the Fear English Stream. There are also a few local roads affected within these local areas in Johnstown Bridge.***

***Longwood - Again, the model was calibrated to the spot gaugings at Castlerickard gauging station and the roughness values of the model adjusted accordingly. However, there is little quantitative data available to calibrate the Longwood and further observations would be necessary to reduce uncertainty in model results. Flooding is predicted at a discrete location in Longwood from the River Blackwater during a 1% AEP event due to insufficient channel***

**capacity inundating the floodplain. During the same 1% AEP flood event this out of bank flood water would be met by flood water coming from the Longwood River caused by an undersized culvert. A non-residential property is affected during this event along with social infrastructure assets.**

**Mornington - There is moderate confidence in the hydrology and hydraulics of the Mornington AFA. The Mornington River is not gauged however the Boyne River is and there is good calibration / validation data available in relation recent flood events. Mornington is affected by both 1% AEP fluvial and 0.5% AEP coastal events. Mornington has a scheme that has significantly addressed the historic risk in the area. There are two separate locations of flood risk which were not examined under the scheme; one of which experiences out of bank flooding emanating from the Boyne Estuary. This is predicted in both fluvially and tidally dominant flood mechanisms and affects residential properties on the edge of Mornington. The tidally dominant scenario affects most properties. In the other location, fluvial flooding is predicted at the 1% AEP event, emanating on the right bank of a small drain, which eventually reaches both residential and commercial properties downstream. There are a number of local roads affected by the 1% AEP fluvial and 0.5% AEP coastal events, including one regional road. A waste water treatment works is also affected along with a number of social infrastructure assets.**

**Navan - There is a long history of flooding events at Navan AFA with relatively good quality recorded water level and flow data at three gauging station locations, with water level data available at a fourth location. The main flood risk within Navan AFA is to receptors adjacent to the River Boyne. There are three areas of predicted flooding which are affected by out of bank flooding due to insufficient channel capacity. A significant number of properties are at flood risk during the 1% AEP event along with a small number of roads, one of which is the R147 - Dublin Road. A utility (Kilcarn Treatment Works) is also situated in this floodplain. There are two further discrete areas of predicted flooding upstream of the River Boyne, along River Blackwater and its tributary, Abbeylands, which are each affected by single flood mechanisms. In these local areas there are a small number of properties and a road at risk.**

**Trim - Despite limited data, the model is considered to be performing satisfactorily for design event simulation. The main flood risk in Trim originates from the River Boyne. There are three areas, interacting along the river, which are predicted to flood during a 1% AEP event due to insufficient channel capacity. There are a small number of properties in each location, both residential and non-residential, at risk of flooding. There is one other discrete area of flooding along the Boycetown River which floods during a 1% AEP flood event. There is one residential property located in this floodplain. Within these floodplains, local roads and a regional road are also affected, along with Trim Waste Water Treatment works and environmental assets.**

## 5 THE UoM07 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 ten AFAs within UoM10 by December 2015, and a series of Progress Group workshops were held (in November and December 2015 and January 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 UoM07 were included at POR stage, however, it should be noted that some were identified during the Flood Risk Review process as being likely to have low risk, in part due to the channel conveyance improvements that had been achieved via the Boyne Arterial Drainage Works. These locations were included, on a precautionary basis, as AFAs within the first cycle of CFRAMS and benefitted by the production of models and mapping providing decision support tools. This early screening assessment was confirmed by the more detailed CFRAM Study optioneering analysis which identified some AFAs as very low predicted risk, and RPS would suggest that these AFAs might have been better omitted or deprioritised from the CFRAM Study and, where appropriate, progressed in parallel by other routes, for example, under the OPW Minor Works programme. For AFAs that were found to have a low level of predicted risk, Public Consultation Days were not held at the Options development stage and ultimately AFA-specific measures were not included in the FRMP; however,

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

Additional optioneering was undertaken at Mornington AFA to address additional flood mechanisms and sources which were not considered by an earlier scheme on the main river channel.

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 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 AFAs for which formal consultation input was received; there were no objections in relation to the UoM07 mapping consultation and the three observations received, relevant to the Mornington/Bettystown areas, provided information on flooding issues and the existing regime which was 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”. This was further identified within the final plan in for 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.***

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

***The main deliverables of the Preliminary Options Report were the AFA specific risk analysis and the assessment of a series of potential flood risk management measures relevant at differing spatial scales of assessment (UoM, Sub-Catchment and AFA). These are presented in the following Tables 5.1 and 5.2 for the risk assessment and potential options for UoM07 respectively.***

**Table 5.1 Flood Risk Analysis UoM07****(Fluvial statistics unless otherwise stated; Coastal = Coastal / Tidal Flooding)**

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event									
	Athboy AFA	Ballivor AFA	Baltray AFA	Drogheda AFA	Edenderry AFA	Johnstown Bridge AFA	Longwood AFA	Mornington AFA	Navan AFA	Trim AFA
<b>Current Scenario (Present Day)</b>										
Event Damage (€)	0	0	615,063 Fluvial 5,230,933 Coastal	26,321,807 Fluvial 40,321,683 Coastal	0	146,669	130,373	1,552,240 Fluvial 458,099 Coastal	11,305,871	1,340,919
No. Residential Properties at Risk	0	0	26 Fluvial 40 Coastal	79 Fluvial 104 Coastal	0	2	0	40 Fluvial 10 Coastal	104	6
No. Business Properties at Risk	0	0	2 Fluvial 5 Coastal	78 Fluvial 120 Coastal	0	1	1	1 Fluvial 0 Coastal	21	6
No. Utilities at Risk	0	0	2 Fluvial 2 Coastal	0	0	0	0	1 Fluvial 1 Coastal	1	1
No. Major Transport Assets at Risk	1	3	5 Fluvial 5 Coastal	32 Fluvial 29 Coastal	1	6	2	7 Fluvial 5 Coastal	13	12
No. Highly Vulnerable Properties at Risk	0	0	0	1 Fluvial 1 Coastal	0	0	1	1 Fluvial 1 Coastal	2	1
No. of Social Infrastructure Assets at Risk	6	1	11 Fluvial 12 Coastal	15 Fluvial 20 Coastal	4	1	4	6 Fluvial 6 Coastal	57	0
No. Environmental Assets at Risk	3	1	3 Fluvial 3 Coastal	3 Fluvial 3 Coastal	4	1	2	4 Fluvial 4 Coastal	7	2
No. Potential Pollution Sources at Risk	0	0	0	0	0	0	0	0	0	0

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event									
	Athboy AFA	Ballivor AFA	Baltray AFA	Drogheda AFA	Edenderry AFA	Johnstown Bridge AFA	Longwood AFA	Mornington AFA	Navan AFA	Trim AFA
<b>Mid-Range Future Scenario</b>										
Event Damage (€)	31,494	18,429	4,603,787 Fluvial 7,509,151 Coastal	120,160,802 Fluvial 121,143,248 Coastal	396,458	715,352	9,081,969	21,452,104 Fluvial 42,500,352 Coastal	59,027,910	9,375,799
No. Residential Properties at Risk	3	1	40 Fluvial 44 Coastal	205 Fluvial 165 Coastal	3	24	80	384 Fluvial 420 Coastal	242	30
No. Business Properties at Risk	2	2	4 Fluvial 5 Coastal	234 Fluvial 262 Coastal	3	1	2	8 Fluvial 10 Coastal	42	31
No. Utilities at Risk	1	0	2 Fluvial 2 Coastal	3 Fluvial 1 Coastal	1	0	0	4 Fluvial 1 Coastal	1	3
No. Major Transport Assets at Risk	2	3	8 Fluvial 7 Coastal	82 Fluvial 39 Coastal	5	10	4	30 Fluvial 27 Coastal	51	15
No. Highly Vulnerable Properties at Risk	0	0	0	1 Fluvial 1 Coastal	0	0	2	3 Fluvial 2 Coastal	2	1
No. of Social Infrastructure Assets at Risk	7	1	13 Fluvial 13 Coastal	7 Fluvial 6 Coastal	6	1	6	10 Fluvial 9 Coastal	79	0
No. Environmental Assets at Risk	3	1	3 Fluvial 3 Coastal	3 Fluvial 3 Coastal	4	1	2	4 Fluvial 4 Coastal	9	2
No. Potential Pollution Sources at Risk	0	0	0	0	0	0	0	0	0	0

Type of Risk	Flood Risk for Design AEP (1% Fluvial & 0.5% Coastal) Event									
	Athboy AFA	Ballivor AFA	Baltray AFA	Drogheda AFA	Edenderry AFA	Johnstown Bridge AFA	Longwood AFA	Mornington AFA	Navan AFA	Trim AFA
<b>High-End Future Scenario</b>										
Event Damage (€)	854,482	560,590	6,983,015 Fluvial 9,021,685 Coastal	285,880,868 Fluvial 224,224,414 Coastal	640,549	6,390,645	13,078,248	67,311,373 Fluvial 140,367,478 Coastal	94,183,322	47,993,844
No. Residential Properties at Risk	8	10	44 Fluvial 48 Coastal	268 Fluvial 180 Coastal	4	67	92	698 Fluvial 1,053 Coastal	448	66
No. Business Properties at Risk	4	6	5 Fluvial 5 Coastal	351 Fluvial 307 Coastal	3	1	2	13 Fluvial 16 Coastal	68	83
No. Utilities at Risk	1	0	2 Fluvial 2 Coastal	3 Fluvial 3 Coastal	1	0	0	4 Fluvial 4 Coastal	3	4
No. Major Transport Assets at Risk	2	7	8 Fluvial 8 Coastal	97 Fluvial 44 Coastal	9	10	4	46 Fluvial 49 Coastal	60	21
No. Highly Vulnerable Properties at Risk	0	0	0	1 Fluvial 1 Coastal	0	0	2	4 Fluvial 4 Coastal	2	0
No. of Social Infrastructure Assets at Risk	7	3	13 Fluvial 13 Coastal	11 Fluvial 8 Coastal	7	1	6	12 Fluvial 13 Coastal	101	8
No. Environmental Assets at Risk	3	1	3 Fluvial 3 Coastal	3 Fluvial 3 Coastal	4	1	2	4 Fluvial 4 Coastal	9	2
No. Potential Pollution Sources at Risk	0	0	0	0	0	0	0	0	0	0



**Table 5.2 Potential Options UoM07**

SSA	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
UoM07	-	-	Sustainable Planning and Development Management Public Awareness Campaign	-	-	-	-	-	-	-	-
UoM07	1%	296	Flood Forecasting and Warning	€ 62,268,579	€ 1,984,502	€ 1,063,138	1.87	55	51.85	-	-
Athboy AFA	1%	0	Maintain Existing Regime	€ 23,037	-	-	-	-	-	Moderate	Moderate
Ballivor AFA	1%	0	Maintain Existing Regime	€ 4,502	-	-	-	-	-	Moderate	Moderate
Baltray AFA	1% Fluvial	45	Option 1 - Hard defences (existing line)	€17,759,319	€ 12,068,742	4.27	2.83	1381	323.57	High	High
	0.5% Coastal		Option 2 - Hard defences (new line)			1.93	6.25	2074	1073		
Drogheda AFA	1% Fluvial 0.5% Coastal	240	Option 1 - Hard defences and flow diversion	€ 111,483,259	€ 50,122,955	15.64	3.2	571	36.5	High	High
			Option 2 - Hard defences, flow diversion and improvement of channel conveyance			16.83	2.98	654	38.9		
			Option 3 - Hard defences, flow diversion and storage			16	3.13	606	37.9		
Edenderry AFA	1%	0	Maintain Existing Regime	€ 53,606	-	-	-	-	-	Moderate	Moderate
Johnstown Bridge AFA	1%	3	Option 1 - Land Use Management	€ 262,526	€ 61,288	-	-	-	-	Moderate	High

SSA	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
Longwood AFA	1%	1	Option 1 - Hard Defences	€ 816,789	€ 21,005	0.028	0.75	341	12,218.70	Moderate	High
Mornington AFA	1% Fluvial 0.5% Coastal	50	Option 1 - Hard Defences	€2,922,658	€1,854,644	0.53	3.52	1042	1977.31	High	High
Navan AFA	1%	125	Option 1 - Hard Defences and do minimum	€ 14,405,940	€ 4,497,487	6.32	0.71	1373	217.1	High	High
Trim AFA	1%	12	Option 1 - Individual Property Protection and Flood Forecasting and Warning	€1,666,605	€ 442,520	0.31	0.29	-	-	Moderate	High
			Maintain Existing Regime	€ -	€ -	-	-	-	-		

## 6 THE DEVELOPMENT OF THE UoM07 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 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, programmes and 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 UoM07 five such AFAs were identified:

- Athboy
- Ballivor
- Edenderry & Environs
- Johnstown Bridge and

- Longwood.

The draft plans are supported by the final core hazard and risk mapping (Volume I) dictated by the Floods Directive and the statutory environmental assessments (Volume II, under the Strategic Environmental Assessment (SEA) Directive and the Habitats Directive. The environmental assessment process, which resulted in an SEA Environmental Report and Natura Impact Statement, influenced:

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

**Key Findings:**

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

***The draft plan incorporates a suite of certain prevention and preparedness measures related to flood risk management that form part of wider Government policy. These measures, set out below, where applicable may be applied across the whole of UoM07, 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***
  - ***Establishment of a National Flood Forecasting and Warning Service***
  - ***Establishment of a Flood Forecasting and Warning System UoM07, comprising gauging stations and a forecasting model system***
- ***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 Boyne Sub-Catchment scale however the following AFA specific measures were identified either under the Eastern CFRAM Study or as part of existing***

**works being undertaken by the OPW or Local Authorities:**

- ***Baltray Flood Relief Scheme: Option 2 - Hard defences (new line)***
- ***Drogheda Flood Relief Scheme: Option 2 - Hard defences, Channel Conveyance & Flow Diversion***
- ***Mornington Flood Relief Scheme: Option 1 - Hard defences***
- ***Navan Flood Relief Scheme: Option 1 - Hard defences, Do Minimum***
- ***Trim – No discrete AFA measure, at risk properties are addressed under the Boyne Flood Forecasting and Warning System Measure (associated with UoM scale activities).***
- ***Maintenance of the Mornington Scheme under the 1945 Arterial Drainage Act as amended by the Arterial Drainage (Amendment) Act, 1995.***

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 Eastern 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 was dependent on the outcome of the consultation process, however, it was intended that the final plan would be supported by prioritised implementation programme of measures.

## **6.2 DRAFT FRMP CONSULTATION & DEVELOPMENT OF THE FINAL FRMP**

*Project-level* consultation activities took place during late 2016 in relation to the draft Flood Risk Management Plans produced by the Eastern Catchment-based Flood Risk Assessment and Management (CFRAM) Study. These comprised workshops with the Eastern CFRAM Progress Group, a stakeholder workshop and a series of Public Consultation Days at twelve venues across the Eastern study area.

These Public Consultation Days took place between September and November 2016, at the following locations (Naas, Clane, Celbridge, Navan, Trim, Wicklow, Dublin City, Dún Laoghaire-Rathdown, Fingal, Tallaght, Lucan 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. This comprised of briefings to elected members, a website based portal for access to the draft plans and supporting materials. The website allowed submissions to be made online in relation to the flood risk management plans and the supporting environmental assessments.

The formal consultation period was open to the public between 22/09/16 and 02/12/16 (with additional time allowed for Local Authority submission up to 23/12/16). The OPW received formal submission via the portal and also in written format and in total received 63 formal submissions.

The OPW, with technical support from RPS, collated responses and reported statutory consultation on the draft FRMPs for UoMs 07, 08, 09 and 10 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 13<sup>th</sup> 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 Eastern CFRAM consultation submissions in relation to the UoM07 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 OPW reviewed the final Plans with particular emphasis on both project-level detail and also national consistency, while the Local Authority Progress Group members provided updated information on relevant plans, programmes and previous projects.

The OPW prioritised 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.

**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 and publically accessible.*

*The final plan generally contained a preferred measure for each AFA (unless there were requirements for further study to determine a preferred option). Whilst the consultations and submissions on the draft FRMP provided valuable information, which has been noted for detailed design, none resulted in a change of the preferred measures for the AFAs within UoM07.*

*The final FRMP measures for UoM07 are presented in Table 6.1.*

**Table 6.1 Summary of Flood Risk Management Measures - UoM07**

Measure	Implementation	Funding
<b>Measures Applicable for All Areas</b>		
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
Establishment of a UoM07 Flood Forecasting and Warning Service	OPW and/or Louth/Meath CoCo - To be confirmed	OPW
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
<b>Catchment / Sub-Catchment Measures</b>		
No Sub-Catchment methods were found to be feasible within UoM07		



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.		
Baltray	OPW and/or Louth CoCo - To be confirmed	OPW
Drogheda	OPW and/or Louth/Meath CoCo - To be confirmed	OPW
Mornington	OPW and/or Meath CoCo - To be confirmed	OPW
Undertake a Detailed Assessment of the Costs of the Potential Measure for the Communities set out below.		
Navan	OPW and/or Meath CoCo - To be confirmed	OPW

## 7 CONCLUSIONS AND RECOMMENDATIONS

### 7.1 TECHNICAL

The Eastern CFRAM Study was a significant and challenging project in terms of the detailed analysis it required, simultaneously across its four 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 in some instances. To inform future Floods Directive planning cycles, RPS would suggest that the main CFRAM studies in this first cycle should have started earlier (in the period when the pre-contract survey arrangements were being progressed) with more programme allowance for the surveys to be distributed, thus allowing staged delivery of Units of Management on all survey and subsequent deliverables. In addition, RPS would recommend that the Survey Framework is renewed so that support for post-CFRAM Study activities, such as responding to comments and queries regarding mapping and updates, remains in place.

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

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

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

In some AFAs or watercourses there was insufficient information to provide high confidence in the analysis of flood risk and this can only be redressed by collecting data as and when events occur. However the best use of available data was made so that in most cases recommendations could be made to progress flood risk management measures without recourse to further study. In other areas where data was sufficient, and especially where site visits to areas that experienced flooding were undertaken during the study, there was more confidence in the findings and these could readily be displayed to the wider public audience. Communities subject to recent events are understandably sensitive, and must be dealt with sympathetically, however in every location where this had occurred RPS were especially well received once it was known that there had been recording of the event to inform the CFRAM Study process. The Flood Event Response enabled complex mechanisms to be better understood and replicated (for example in the Poddle system) 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 Eastern 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 Eastern 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 Eastern CFRAM Study benefitted from the regular and ongoing communication between the OPW 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 Eastern 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.
- Early collaboration via a National Technical Co-ordination group was of some benefit, despite the group’s large membership, these two day meetings evolved into targeted workshops on specific topics. RPS would suggest that further such workshops would have been of benefit in the latter stages of the projects and whilst the OPW’s production of the draft plan template and covers, and their review of the draft Plans, ensured a reasonable degree of consistency, this may have been facilitated by the continuation of the co-ordination group or workshops engendering more of an ethos of partnership and providing more direct communication and access to policy level decision. For example, specific topics could have been; the use of the unit cost database and inputs to the draft FRMP.
- The longevity of the studies posed difficulties in terms of achieving and maintaining engagement with stakeholders and the wider public. RPS would endorse our early views that the quality, rather than quantity, of consultation events remains the focus of future consultation phases, that the publicising the events is given a high priority going forward with engagement of national groups under an overall communications strategy, opportunities to tap into similar

local engagement programmes are utilised (for example WFD engagement), and, that information be made available using flexible electronic visualisation applications as well as hard copy deliverables.

- It is noted that the OPW are already engaged with a number of relevant groups, for example national stakeholders and cross border fora, which are beyond the remit of the CFRAM studies to review. However it is considered important that all engagement is maintained.

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

It should be noted that at all stages of Eastern 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 Plan, 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.

### **7.3 GENERAL**

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

There are many peripheral, but nevertheless valuable, activities which could have been further explored within the Floods Directive’s first cycle assessment; however, due to the number of AFAs which were being assessed and brought together for catchment-scale analysis, focus had to be maintained on the project’s core activities. Whilst other analyses were piloted within various studies (for example culvert blockage, Natural Flood Risk Management and detailed climate change adaptation) these were not able to be implemented across the country due to programme constraints. RPS would recommend that such additions and innovations are taken forward during the Flood

Directive's second cycle alongside the implementation of the first cycle's plans. In particular, RPS would recommend trialling/piloting measures, such as Natural Flood Risk Management and wetland/bog restoration, which may be of mutual benefit to the implementation of the Water Framework and Habitats Directives, as these integrated catchment measures are untested in the Irish context but may be relevant tools to help offset the impacts of future changes assessed under the first cycle of CFRAM studies and provide benefit where structural schemes are not financially viable.

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

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

The CFRAM studies in this first cycle were ambitious and whilst they had been informed by pilot studies there were areas where the methodology was untested at a CFRAM Study scale which led to some delays and iteration throughout the process. The methodology and scope for the second cycle should be developed as soon as possible to enable pilot studies and trials to be undertaken and a realistic programme to be developed. This should enable more efficient working in the next cycle.

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