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DODDER CATCHMENT FLOOD RISK MANAGEMENT PLAN

November 2014

RPS

Dodder Catchment-based Flood Risk Assessment and Management Study

Flood Risk Management Plan

DOCUMENT CONTROL SHEET

Client	Dublin City Council					
Project Title	Dodder Catchment-based Flood Risk Assessment and Management (CFRAM) Study					
Document Title	Dodder Catchment Flood Risk Management Plan					
Document No.	IBE0064FinalFRMP					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No. of Appendices
	1	1	83	1	1	6

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
1	Draft	GG, AJ, MW, KM	Andrew Jackson	Grace Glasgow	Belfast	Feb 2011
2	Final Draft	GG, AJ, MW, KM	Andrew Jackson	Grace Glasgow	Belfast	22/07/2011
3	Final (F01)	GG, AJ, MW, KS	Andrew Jackson	Grace Glasgow	Belfast	07/11/2014

Acknowledgements

In 2006, the Office of Public Works (OPW), Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council commenced work on a Catchment-based Flood Risk Assessment and Management (CFRAM) Study for the Dodder Catchment, as a means of addressing the high levels of existing flood risk around the River Dodder, its tributaries and estuary, and the potential for significant increases in this risk in the future.

In January 2007, RPS was appointed as lead consultant for the Dodder CFRAM Study.

The Dodder CFRAM Study was one of the first pilot CFRAM Studies of the new CFRAM Programme, which is at the core of the delivery of the new Flood Policy adopted by the Irish Government in 2004, shifting the emphasis in addressing flood risk towards *a catchment-based, pro-active approach for identifying and managing existing, and potential future, flood risk*.

The Dodder CFRAM Study, and the Dodder Catchment Flood Risk Management Plan (FRMP), have been prepared by RPS under the supervision of the OPW and its partners, Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council.

An in-house OPW Project Management Team managed the work of the consultant on the study. A Project Steering Group, which included representatives from OPW, Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council, was responsible for overseeing and directing the study, and reviewing key outputs and deliverables.

OPW wishes to acknowledge the support and advice of the Steering Group representatives, as well as the input from a wide range of stakeholders and other interested parties. Sincere thanks are also extended to the project team at RPS for their expertise, commitment and cooperation.

The project team would like to acknowledge and thank the data suppliers who have contributed to the project. These are listed as follows:

Data suppliers:
An Post
Central Statistics Office
Coastal Marine Research Centre
Department of Agriculture Fisheries and Food
Department of Communications, Energy and Natural Resources
Department of the Environment Heritage and Local Government
Department of the Environment Heritage and Local Government (National Parks and Wildlife Service)
Dublin City Council,
Dublin Port
Dún Laoghaire-Rathdown County Council
Eastern River Basin District
Electricity Supply Board
Environmental Protection Agency
Forest Service
Geological Survey of Ireland
Paul Corrigan and Associates
Mary Tubridy & Associates
Met Éireann
Natura Environmental Consultants
Ordnance Survey Ireland
The Office of Public Works (OPW)
South Dublin County Council
The Heritage Council

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EXECUTIVE SUMMARY

Introduction

This document is the final Dodder Catchment Flood Risk Management Plan (FRMP) (often referred to hereafter as 'the FRMP' or 'the plan'). It is a non-technical document for consultation that summarises the work of the Dodder Catchment-based Flood Risk Assessment and Management (CFRAM) Study and elaborates on the findings and recommendations of the study. It includes a set of prioritised studies, actions and works (structural and non-structural) to manage the flood risk in the area in the long-term, and provides an indicative programme for implementation.

This plan document is supported by separately bound volumes of flood maps, as well as by Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) documents. There is also an extensive library of technical background documents associated with the FRMP and the study generally. All of the documentation and mapping is available on the Dodder CFRAM Study webpage of the Dublin City Council website: http://www.dublincity.ie/main-menu-services-water-waste-and-environment-water-projects/river-dodder-catchment-flood-risk.

The preparation of the Dodder Catchment FRMP, and supporting materials, was undertaken by RPS on behalf of the OPW and its partners (Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council) who manage and monitor flooding aspects along the River Dodder and its tributaries on an on-going basis. The FRMP will be reviewed on a six-yearly basis, as required by the Floods Directive.

The involvement of external parties has been essential in the development of the Dodder Catchment FRMP and associated SEA. Throughout the Dodder CFRAM Study, it was important to both meet statutory requirements for consultation with relevant parties; and to ensure that the knowledge, experience and views of stakeholders and the general public were taken into account throughout the development of the FRMP.

This final Dodder Catchment FRMP document, bound volumes of flood maps and SEA Statement were put on public display from DATE to DATE at the following Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council Offices throughout the catchment (Civic Offices, Wood Quay, Dublin 8; County Hall, Marine Road, Dun Laoghaire, County Dublin; County Hall, Tallaght, Dublin 24). Notifcation was published in XX newspapers on DATE.

Background

Flood risk in Ireland has historically been addressed through a reactive approach and the use of structural or engineered solutions. In 2004 the Irish Government adopted a new policy that shifted the emphasis towards a catchment based context for managing flood risk, with more proactive risk assessment and management, and increased use of non-structural and flood impact mitigation measures.

CFRAM Studies, and their product Flood Risk Management Plans (FRMPs), are at the core of this new national policy for flood risk management and the strategy for its implementation. This policy is in line with international best practice and meets the requirements of the EU Floods Directive.

The Dodder CFRAM Study was one of the first pilot projects for the National CFRAM programme within Ireland, and amongst the stated objectives for it are to:

- Identify and map existing and potential future flood hazard and risk within the catchment;

- Identify viable structural and non-structural measures and options for managing the flood risk;

- Build a strategic information base necessary for making informed decisions in relation to managing flood risk;

- Develop an environmentally, socially and economically appropriate long term strategy (Flood Risk Management Plan, FRMP) to manage the flood risk and help ensure safety and sustainability of communities in the catchment (Table 8-3);

- Carry out a Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) to ensure that environmental issues and opportunities for enhancement are considered;

- Comply with the requirements of the EU Floods Directive and its transposing regulations.

The Dodder catchment

The River Dodder is one of Dublin's best known and most important rivers. It flows from Kippure Mountain through bogland, light forest and agricultural land before entering urban Dublin. The Dodder collects rainwater from a 12,081 hectare (120.8 km^2) catchment and discharges to the Liffey Estuary.

The River Dodder's catchment stretches from Ringsend in Dublin City, west as far as Tallaght and southwest as far as Kippure in the Dublin Mountains. It rises above Glenasmole and in its upper reaches it forms a reservoir system which is an integral part of the water supply to Dublin. It flows down through the suburban areas of Tallaght and Rathfarnham and through the city areas of Donnybrook and Ballsbridge before discharging into the Liffey Estuary at Ringsend. The lower section of the river is tidal up to the weir upstream of Ballsbridge.

The upper portion of the catchment from the source to Old Bawn in Tallaght includes the two Bohernabreena Reservoirs (Upper and Lower) and their spillways. This section is mainly rural while the lower catchment is already heavily developed with residential and industrial land uses.

There are five main tributaries whose sub-catchments drain into the River Dodder; the Tallaght Stream, the Owendoher, the Whitechurch, the Little Dargle and the Dundrum Slang, all of which are heavily urbanised streams

The Dodder's surrounding parklands are an extremely important amenity to Dublin and the river is widely used by fishermen and a variety of sporting and recreational interests over its 27 km long course.

The River Dodder has a history of flooding and is known as a "flashy" river with a quick response to rainstorms. This is due to its source being in the Dublin mountains which provides it with a steep gradient and periods of high rainfall.

In the last century it has overflowed its banks on numerous occasions causing damage to adjacent properties. A number of areas have experienced river and/or tidal flooding within the Dodder catchment. These flooding problems mainly cause damage to public roads and properties also flooding parkland in the urban areas of the Dodder catchment and result from both fluvial (river) and tidal sources. There is also a degree of rural flooding in the upper catchment resulting from fluvial flooding.

One of the most severe floods in recent times occurred on 25 August 1986 (Hurricane Charlie) with well over 300 properties affected by the flooding, leading to much human misery and anxiety. During this storm the reservoir dams in Bohernabreena were within millimetres of being overtopped. To secure these dams, new spillways have since been constructed at the Bohernabreena reservoirs to cater for the "Probable Maximum Flood" (which is 383 m^3/s at Bohernabreena).

Another notable recent flooding event occurred on 1 February 2002 when there was a significant high tide. Over 600 properties were flooded on the lower Dodder downstream of Lansdowne Road Bridge during this event.

The severe flood event of 23-24 October 2011 caused widespread flooding throughout the Dodder catchment.

In order to increase the level of protection on the River Dodder, the following work was carried out to the most vulnerable areas:

- In 1986 flood walls and embankments were constructed at Donnybrook and along Anglesea Road
- In 2003 work was started on the Dodder Estuary at Fitzwilliam Quay and Stella Gardens
- In 2006 work was completed on the Bohernabreena Reservoir Spillways
- A pipe was submerged beneath the river which had originally crossed it at Beatty's Cottage, Beatty's Avenue;
- Ongoing Lower Dodder Flood Alleviation Work between 2007 and 2010.

Study approach

The methodology adopted for the Dodder CFRAM Study has been thorough and to a level of detail appropriate for the development of a FRMP and associated flood mapping. It has included the collection of survey data and the assembly and analysis of meteorological, hydrological and tidal data. This data has been used to develop a suite of hydraulic computer models of the River Dodder, its tributaries and Dublin Bay. Flood maps are one of the main outputs of the study and are the way in which the model results are communicated to end users. The key types of mapping developed included:

- Flood extent maps – illustrate the estimated area inundated by a flood event of a given annual exceedance probability (AEP). These maps also show levels of confidence in the flood extents, plus water levels, flows and defended areas.

- Flood depth maps – illustrate the estimated flood depths for the likely areas inundated by a particular flood event;

- Flood velocity maps – illustrate the likely speed of the flood water for a particular estimated flood event using graduated colours; and

- Flood hazard maps – illustrate the harm or danger which may be experienced by people due to a flood event of a given AEP, calculated as a function of depth and velocity of flood waters. Flood hazard was defined based on the approach presented in the DEFRA/Environment Agency Research & Development project "Flood Risks to People" FD2320/FD2321.

The flood maps allow identification of likely locations within the Dodder Catchment at risk of flooding; the impacts of flooding have been considered under three categories:

- Economic: loss or damage to buildings or infrastructure, and the disruption of activities that have economic value;

- Social: loss or damage to human life, health, community and social amenity; and

- Environmental and Heritage: consideration of the sensitivity of the river environment, habitats and species, plus the cultural and historical environment, to flooding.

A damage assessment was undertaken to determine the direct economic damages to properties and infrastructure in the Dodder catchment as a result of current levels of flood risk. As expected, the greatest economic property damages occur in the lower Dodder area, which has the highest density of properties as well as significant flood risk due to both fluvial and tidal flooding. The Whitechurch Stream and Dundrum Slang are at moderate economic flood risk and the majority of the remaining urban areas have a lower economic risk of flooding. The most significant number of properties at social risk is again located in the Lower Dodder (Donnybrook area) which is at risk from fluvial and tidal flooding.

Where flood risk is significant, the study has identified a range of potential flood risk management options to manage these risks, including structural options (e.g. flood walls and embankments) and non-structural options (e.g. flood forecasting and development control). The options were developed at four spatial scales:

- **Catchment scale**: the Dodder catchment study area (~120 km^2);

- **Sub catchment or analysis unit (AU) scale**: main sub-catchments individually, or grouped in cases where flood extents interact (e.g. the Dodder (upper, middle and lower) or five main tributaries);

- **Areas of potential significant risk (APSR) or flood cell scale**: existing urban areas with high degrees of flood risk and, in some cases, localised areas (flood cells) that may have stand-alone flood risk management options;

- **Individual risk receptor (IRR)**: individual assets of particular economic or social value that has been identified as being prone to flooding and hence represents a significant risk in its own right, such as transport and utilities infrastructure, which may require specific consideration during the development of the flood risk management options.

A three stage process has assessed flood risk management options against defined flood risk management objectives. A total of 15 objectives were applied to the Dodder Catchment under four different categories: economic; social; environmental and heritage; and technical and other. The option assessment process starts with preliminary evaluation of a long list of measures for each AU and APSR to filter out any that are not applicable. It culminates in a detailed multi criteria analysis (MCA) to determine the preferred option(s) for each assessment area. The process has been developed and used to ensure that the assessment of flood risk management options is evidence-based, transparent, and inclusive of stakeholder and public views (through stakeholder consultation on the flood risk management options and MCA process).

The scoring system was developed so that any option with an overall score greater than zero would be considered as being more beneficial than the current scenario and was taken forward as a preferred option. Conversely any option with a negative score was considered as being worse than the current scenario and was therefore eliminated from the process.

It should be noted that a factor in the technical assessment of all potential options was the sustainability and adaptability of the option to future flood risk and climate change. An objective was therefore considered under the technical criteria which assessed the ability of each of the proposed options to be adapted at later date as more detail about the effects of climate change is established. This is reflected in the technical objective where an option is assessed against its adaptability to account for flood risk from middle range and high end future flood scenarios.

The Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) processes assessed the potential effects of implementation of the FRMP. A range of potential negative and positive impacts were identified. Mitigation measures were identified and are included in Chapter 7 of this FRMP, and have as such been adopted as part of this plan.

The Flood Risk Management Plan

The final Dodder Catchment FRMP does not aim to provide solutions to all of the flooding problems that exist in the catchment; that would be neither feasible nor sustainable. What it does aim to do is to identify viable structural and non-structural options for managing the flood risks within the catchment as a whole and for localised high-risk areas.

The Dodder Catchment FRMP components have been derived from the MCA output and comprise options with positive overall MCA scores and that are cost-beneficial. In summary, it includes:

- At catchment level: tidal and/or fluvial flood forecasting systems are proposed for widespread coverage in conjunction with public awareness and flood warning programmes in addition to maintenance, monitoring and policy measures such as spatial planning and flood planning;

- At Analysis Unit level: one option consisting of earth embankment flood defences is recommended (Little Dargle):

- Within four APSRs/flood cells: proposals for flood defences are recommended (Lower Dodder – Donnybrook, Shanagarry Apartments and Smurfit Site, Orwell Gardens and St Endas and Tara Hill), with the latter case augmented by channel conveyance.

The assessment of the individual risk receptors indicates that none justify flood defences in their own right, whilst others are viable where they are within the coverage of the preferred options for the respective APSR or Analysis Unit. Proactive planning for diversion arrangements for flooded roads and alternative bus services for flooded railways will alleviate the situation for transport infrastructure. For utilities infrastructure such as water and waste water treatment plants, flood alleviation can be achieved through provision of flood defences, maintenance of existing defences, or emergency planning for closure of the plants during floods and alternative supply arrangements, or even closure and re-location of the plant. The owners of the receptors, usually the local authorities, will be consulted to agree the action to take.

An indicative programme for implementation of the Dodder Catchment FRMP is set out with timescales suggested according loosely with the cycles of the EU Floods Directive, namely:

- first phase: implementation to 2015;
- second phase: 2016 to 2022; and
- third phase: 2023 onwards.

These timescales, particularly after 2016, may change due to economic conditions and also where flood risk management sits within national priorities.

In summary, development of options beyond the CFRAM Study stage will be based on MCA scores, with priority being given to the lower cost options as well as those that have been demonstrated to be most cost-beneficial. Non-structural options, which are generally lower cost, are likely to be the first to be taken forward, followed by structural options over a longer timescale. All structural options will have a lead-in time for full scheme development and detailed design, and a 5-10-year programme or longer might be expected for some structural options.

The proposed phasing for implementation of the Dodder Catchment FRMP is given in Table ES-1, together with the various organisations responsible for each proposed option.

Table ES-1: Phasing of the Dodder Catchment FRMP

Developments along the Dodder to date:

- Dublin Coastal Flood Protection Project 2008;
- Works Downstream of the Lansdowne Road (Newbridge bridge) completed 2007 – 2010;
- Lansdowne road (Newbridge bridge) to Irish Rail Bridge at Lansdowne, works are at planning stages;
- Raising of Lansdowne bridge (Newbridge bridge) and London bridge parapets are at the planning stages;
- Upstream of the Irish Rail bridge to Herbert Park Hotel bridge, This phase is at tender stages for the appointment of a consultant who is to be engaged to carry out the detailed design for the construction of defences, as per the Dodder Catchment Flood Risk Management Assessment Plan.

2011	2012-2013	2014-2015	2016+	Who	Estimated Cost
Non- Structural Options					
Undertake the Strategic Review of Flood Forecasting & Warning.	Implement findings of Strategic Review of Flood Forecasting and Warning.		Operate and maintain flood Forecasting and Warning Systems.	DCC SDCC DLRD (OPW)	0 K
Operate and maintain Dublin Tidal Predictions, through Dublin's flood Forecasting, Warning Systems (Triton system) and Tide watch, and carry out any upgrades.				DCC (OPW)	50 K
Enhance local awareness and education. Maintain, review, update, and practice flood event response plans.				DCC SDCC	0 K

<table>
<tr><th>2011</th><th>2012-2013</th><th>2014-2015</th><th>2016+</th><th>Who</th><th>Estimated Cost</th></tr>
<tr><td colspan="4"></td><td>DLRCC (OPW)</td><td></td></tr>
<tr><td colspan="4">Implement the Guidelines on Spatial Planning and Flood Risk Management (2009).</td><td>DCC, SDCC, DLRCC</td><td>0 K</td></tr>
<tr><td colspan="4">Bohernabreena Dam and Spillways, regularly structurally inspect the dam and spillways, Manage and Monitor levels.</td><td>DCC</td><td>0 K</td></tr>
<tr><td colspan="5">Non- Structural Options (cont.)</td><td rowspan="2">0 K</td></tr>
<tr><td colspan="4">Maintain, coordinate and operate Hydrometric Monitoring Equipment where required. Located at Orwell Road, Beatty's Cottages, Alexandra Basin, Bohernabreena, Frankfort Ave (DLRD), adj. Tuning Fork Public House, Owendoher (SDCC), any existing and new rain gauges.</td><td>DCC
SDCC
DLRCC
EPA</td></tr>
<tr><td colspan="5">Existing Flood Defences</td><td rowspan="2">0 K</td></tr>
<tr><td>Determine defence asset monitoring and maintenance programme</td><td colspan="3">Proactive maintenance of existing defence assets.</td><td>DCC
SDCC
DLRCC
(OPW)</td></tr>
<tr><td colspan="5">Individual Risk Receptors</td><td rowspan="2">0 K</td></tr>
<tr><td colspan="4">Inform owners and operators of interim risk assessment and/or management measures as appropriate, ESB substation at Lower Dodder Road, Irish Rail Lansdowne Bridge, numerous embassies, RDS, AIB bank, Aviva stadium, Shelbourne Park Greyhound Stadium etc.</td><td>DCC
SDCC
DLRCC
(OPW)</td></tr>
<tr><td colspan="5">Catchment Flood Risk Management Plan (FRMP)</td><td rowspan="3">0 K</td></tr>
<tr><td rowspan="2">Following public consultation, complete FRMP and seek adoption by all the 3 local authorities.</td><td colspan="3">Implement the various recommendations of the FRMP</td><td rowspan="2">OPW DCC
SDCC
DLRD</td></tr>
<tr><td></td><td>In 2015 review the FRMP, taking account of any changes and / or new information on possible impacts of climate change.</td><td>In 2021 review the FRMP, taking account of any changes and / or new information on possible impacts of climate change.</td></tr>
</table>

2011	2012-2013	2014-2015	2016+	Who	Estimated Cost
Liffey River to Lansdowne Road (Newbridge Bridge)					500 K
Obtain Part 8 planning permission for the raising of the Bridge Parapets on Lansdowne Road (Newbridge) and London Bridge bridges	Design and construct the raising of the bridge parapets	Maintain and inspect bridge parapets.		DCC OPW	
Maintain and operate defences				DCC	
Lansdowne Road (Newbridge Bridge) to the Lansdowne road Irish Rail bridge					1.5 M
Obtain Part 8 planning for the construction of defences.	Design and construct the defences.	Maintain and operate defences.		DCC OPW	
Lower Dodder - DS Donnybrook (Phase 2C, 2D & 2E. works between Lansdowne Road Irish Rail bridge and the Smurfit weir)					10 M
Appoint Consultant. Complete Preliminary Designs, and start Part 8 Planning Procedure.	Obtain planning permission. Complete detailed designs. Carry out and complete construction. Maintain existing defences.		Maintain and operate defences.	DCC OPW	
St Enda's & Tara Hill (Whitechurch)					1.8 M
Procure consultant and design new flood defences. Obtain planning permission for defences		Construct new flood defences, undertake dredging and weir removal	Maintain defences	SDCC, (OPW) (DCC)	
Little Dargle					15 K
Design and construct new flood defences.		Maintain defences		DLRCC	
Smurfit Papers Mills to Shanagarry Apartments					3.23 M
Inspect defences and determine works.		Obtain part 8 planning	Construct defences	DCC (OPW)	
Maintain defences.					
Orwell Gardens					604 K

2011	2012-2013	2014-2015	2016+	Who	Estimated Cost
Design and construct new flood defences.		Maintain defences		DLRCC	

Note: Coastal Flood Protection along Sandymount to be progressed. This coastal protection scheme will also protect Ringsend to Merrion Gates.

1 INTRODUCTION

This document is the final Dodder Catchment Flood Risk Management Plan (FRMP) (often referred to hereafter as 'the FRMP, or 'the plan'). It is a non-technical document for consultation that summarises the work of the Dodder Catchment-based Flood Risk Assessment and Management (CFRAM) Study and elaborates on the findings and recommendations of the study. It includes a set of prioritised studies, actions and works (structural and non-structural) to manage the flood risk in the area in the long-term, and provides an indicative programme for implementation.

This plan document is supported by separately bound volumes of flood maps, as well as by Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) documents. There is also an extensive library of technical background documents associated with the FRMP and the study generally. All of the documentation and mapping is available on the Dodder CFRAM Study webpage of the Dublin City Council website: http://www.dublincity.ie/main-menu-services-water-waste-and-environment-water-projects/river-dodder-catchment-flood-risk.

The preparation of the Dodder Catchment FRMP, and supporting materials, was undertaken by RPS on behalf of the OPW and its partners (Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council) who manage and monitor flooding aspects along the River Dodder and its tributaries on an on-going basis. The FRMP will be reviewed on a six-yearly basis, as required by the Floods Directive.

This final Dodder Catchment FRMP document, bound volumes of flood maps and SEA Statement were put on public display from DATE to DATE at the following Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council Offices throughout the catchment *(Civic Offices, Wood Quay, Dublin 8; County Hall, Marine Road, Dun Laoghaire, County Dublin; County Hall, Tallaght, Dublin 24*). Notifcation was published in XX newspapers on DATE.

1.1 BACKGROUND

Flooding is a natural process that can happen at any time in a wide variety of locations and its causes, extent and impacts are varied and complex. There is a consequent risk when people, human assets, property, infrastructure, the natural environment, agricultural land, heritage, etc., are present in the area that floods.

Flood risk in Ireland has historically been addressed largely through a reactive approach and the use of structural or engineered solutions. In line with internationally changing perspectives, the Irish Government adopted a new policy in 2004 that shifted the emphasis in flood risk towards:

- a catchment context for managing risk;
- more proactive risk assessment and management, with a view to avoiding or minimising future increases in risk; and
- increased use of non-structural and flood impact mitigation measures.

Notwithstanding this shift, engineered solutions to manage existing risks are likely to continue to form a key component of any flood risk management strategy.

Catchment-based Flood Risk Assessment and Management (CFRAM) Studies, and their product Flood Risk Management Plans (FRMPs) and accompanying flood mapping, are at the core of this new national policy for flood risk management and the strategy for its implementation. These studies have been developed to meet the requirements of the EU Directive on the assessment and management of flood risks (the Floods Directive) (2007/60/EC). The Floods Directive was transposed into Irish law by SI 122 of 2010 European Communities (Assessment and Management of Flood Risks) Regulations 2010, as amended by SI 470 of 2012.

Underlying this policy shift is the acceptance of flooding as a natural phenomenon and the realisation that we must learn to live with and adapt to flood events. An integrated, holistic and catchment-based approach to flood risk management is the way forward, an approach that is consistent with, and complements, the EU Water Framework Directive (WFD) (2000/60/EC).

1.2 AIMS

In line with Government policy, the Dodder CFRAM Study was initiated; its main objectives being to:

- Identify and map existing and potential future flood hazard and risk within the catchment;

- Identify viable structural and non-structural measures and options for managing the flood risk;

- Build a strategic information base necessary for making informed decisions in relation to managing flood risk;

- Develop an environmentally, socially and economically appropriate long term strategy (Flood Risk Management Plan, FRMP) to manage the flood risk and help ensure safety and sustainability of communities in the catchment (Table 8-3);

- Carry out a Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) to ensure that environmental issues and opportunities for enhancement are considered;

- Comply with the requirements of the EU Floods Directive and its transposing regulations.

1.3 SCOPE

The flood hazards and risks to be addressed include both those that currently exist and those that might potentially arise in the future, as a result of, for example, climate change. The risk management measures, options and management plan should equally address both existing and future hazards and risks.

While the Dodder CFRAM Study considers flood risk on a catchment-wide basis, it has focused on areas where the flood risk was understood to be, or might become, significant (Areas of Potentially Significant Risk (APSRs)/flood cells and individual risk receptors). These areas and properties were identified by the OPW with Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council based on historic records of flooding and the local knowledge of the three council's and OPW staff.

The Dodder CFRAM Study aimed to develop a Flood Risk Management Plan (FRMP) – this document. It did not aim to develop detailed designs for individual flood risk management measures.

This FRMP document includes a set of prioritised studies, actions and works (structural and non-structural) to manage the flood risk in the area in the long-term, and make recommendations in relation to appropriate development planning.

The Floods Directive requires consideration of pluvial flooding which is currently being studied at national level by the OPW and in Dublin City by the FloodResilienCity (FRC) project for which Dublin City Council is a partner organisation. The Floods Directive also requires consideration of groundwater flooding, which is not a significant flooding source in the Dodder catchment. These additional flooding aspects will be addressed by a Floods Directive plan compliance review that will be undertaken by the Eastern CFRAM Study before the Dodder Catchment FRMP is incorporated into the Liffey FRMP and reported to the EU in 2015.

1.4 LEGISLATIVE FRAMEWORK

1.4.1 National flood risk management policy

To be valid, the FRMP must comply with Government policy and regulation on flood risk management, which in turn should be consistent with EU policy, for example the EU Water Framework Directive (WFD) and the Floods Directive.

Government policy is contained in the Report of the Flood Policy Review Group (OPW, 2004). The primary objective is to "minimise the national level of exposure to flood damages through the identification and management of existing, and particularly potential future, flood risks in an integrated, proactive and river basin based manner".

The policy pursues a two-pronged approach to flood management with a greater level of importance attributed to non-structural flood relief measures supported, where necessary, by traditional structural flood relief measures.

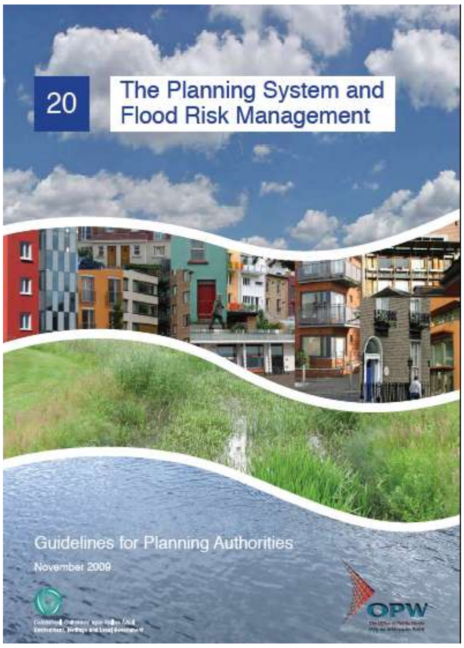
The OPW is the lead agency in delivering this policy, and has responsibility for advising Government on flood risk matters and for coordinating the activities of all organisations with responsibilities for flood risk management. As lead agency, the OPW has been designated as the Competent Authority with respect to implementation of the Floods Directive. The OPW also has powers and responsibilities in relation to the implementation and maintenance of arterial drainage and flood relief schemes and of other flood risk management measures for flood risks arising from sources such as rivers, lakes, estuaries and the sea.

1.4.2 Flood risk management and planning

In addition to addressing existing risk, it is essential to manage flood risk long-term ensuring that communities develop in a sustainable manner so that potential future increases in flood risk are avoided or minimised.

Development in flood-prone areas can create flood risk, for example, by locating houses and other properties in areas where they may be flooded or by worsening the flood risk to properties up- or downstream. Development in areas outside of the floodplain can also increase flood risk to existing development downstream through increased runoff rates and volumes.

The Guidelines for Planning Authorities on the Planning System and Flood Risk Management (OPW, 2009), published under Section 28 of the Planning Act, set out a transparent and robust framework to ensure the full consideration of flooding and flood risk in both planning and development management in order to ensure that flood risk is not created or exacerbated. The Guidelines set out Government Policy on appropriate planning and development with respect to flood risk and should be followed by all planning authorities.



Other organisations have powers and responsibilities for, or related to, flood risk management. These would include the Local Authorities and riparian owners (that is, parties living or located on the bank of the watercourse) and other agencies.

In general the potential future land-use changes in the catchment will be based, in the short to medium term, on the published statutory and non-statutory spatial planning documents produced by Government and the planning authorities within the catchment. Table 1-1 contains a list of the spatial planning documents that are relevant to flood risk management within the catchment. Future iterations of policies within these planning documents will need to take account the flood maps prepared by the Dodder CFRAM Study and the flood risk management actions recommended in the Dodder Catchment FRMP.

The Dodder Catchment FRMP presents an opportunity to identify areas at risk of flooding so as to avoid inappropriate development in the floodplains, and to inform decisions and risk assessment where development is considered necessary or appropriate in areas of flood risk. The FRMP, and the accompanying flood mapping, therefore provide a decision support framework for the implementation of these Planning Guidelines, in particular the flood extent outlines delineate three flood zones (A, B and C) referred to in the Planning Guidelines.

There are also likely to be planning issues that could present opportunities for partnerships with regard to integrated flood management and development schemes.

The recommended actions in this plan take account of appropriate development controls as set out at national, regional and local levels (the existing and future flood maps produced as part of the study do not assume that the land currently zoned for development will be developed).

Table 1-1 Relevant spatial planning and development plans

Relevant Plan/Policy	Objective
National Development Plan, 2007-2013	The €184 billion National Development Plan 2007-2013 builds on the significant social and economic achievements of the NDP/CSF (2000-2006). Launched in January 2007, and entitled Transforming Ireland - A Better Quality of Life for All, this new seven year plan is another major milestone in building a prosperous Ireland for its people, characterised by sustainable economic growth, greater social inclusion and balanced regional development.
National Spatial Strategy, 2002-2020	A coherent national planning framework for Ireland for the next 20 years. The NSS aims to achieve a better balance of social, economic and physical development across Ireland, supported by more effective planning.
National Strategic Reference Framework, 2007-2013	Sets out policy context within which funding available to Ireland under the EU structural funds may be applied.
The Planning System and Flood Risk Management - Guidelines for Planning Authorities (November 2009)	Statutory guidelines aimed at ensuring a more consistent, rigorous and systematic approach to the avoidance and minimisation of potential future flood risk and to fully incorporate flood risk assessment and management into the planning system. Under these guidelines development vulnerable to flooding will only be permitted by planning authorities in areas at high or even moderate risk of flooding in exceptional circumstances where decisions are based on clear and transparent criteria. The Guidelines require the planning system at national, regional and local levels to: • Avoid development in areas at risk of flooding, particularly in floodplains, unless there are demonstrable, wider sustainability grounds that justify appropriate development and where the flood risk can be reduced or managed to an acceptable level without increasing flood risk elsewhere; • Adopt a sequential approach to flood risk management when assessing the location for new development based on avoidance, reduction and mitigation of flood risk; and • Incorporate flood risk assessment into the process of making decisions on planning applications and planning appeals
Regional Planning Guidelines for the Greater Dublin Area 2004-2016	The regional planning guidelines give regional effect to the National Spatial Strategy. These guidelines provide the consolidation of development in the Metropolitan Area and articulate the vision and strategy for the region in economic and social terms. The guidelines recommend that all future development of any significant size should be undertaken in the context of Local Area Plans.
Dublin City Development Plan, 2005-2011	The City Development Plan proposes a sustainable and vibrant city in the context of the strategy for the development of a Greater Dublin'. It promotes the consolidation of the city, maximising efficient use of land and integrating land use and transport.
Dublin City Development Plan, 2011-2017	This Development Plan differs from previous plans by taking a new approach that looks beyond the next six years and sets out a vision of Dublin twenty years hence. The Dublin 2030 vision is based on two simple ideas, sustainability and quality of life. To reach this long-term goal, the vision is broken down into smaller, more achievable steps, beginning with three aspects (known as the "Core Strategy")of the vision that could be achieved by 2017.

Relevant Plan/Policy	Objective
South Dublin County Development Plan 2004-2010	The main aim is to provide for the future of wellbeing of the residents and to facilitate the future sustainable development of the county as a vibrant place in which to live and work, visit and enjoy within the strategic framework of the greater Dublin area.
South Dublin County Development Plan 2010 - 2016	The plan sets out a vision and an overall strategy for the proper planning and sustainable development of the County for the six-year period 2010 – 2016. It also sets out guiding policies and objectives for the development of the County in terms of physical growth and renewal, economic, social and cultural activity, and environmental protection and enhancement
Dun Laoghaire Rathdown County Development Plan 2010-2016	To plan for and co-ordinate operate sustainable development in Dun Laoghaire Rathdown based on high quality residential, working and recreational environments and sustainable transportation patterns. To create a high quality physical environment to meet the growing needs of those living working or visiting the county in a sustainable, inclusive, balanced and integrated way and where communities can thrive in an ecologically, socially and economically sustainable manner.
Glenasmole/ Bohernabreena Housing & Planning Study, 2002	To plan for the sustainable development of the Glenasmole/Bohernabreena area which lies at the foothills of the Dublin Mountains approximately 15km from Dublin city centre and just south of the built up area of Tallaght. It lies in the administrative area of South Dublin County Council. The proximity of the area to the urban fringe has put it under increasing development pressure.
Ballsbridge Draft Local Area Plan	Draft statement with maps, plans and drawings setting out objectives for the proper planning and sustainable development of the Ballsbridge area.
Stillorgan Local Area Plan 2007 - 2012	Plan for the proper planning and sustainable development of the area - Dun Laoghaire Rathdown County Council.
Glencullen Local Area Plan 2008 - 2013	Plan for the proper planning and sustainable development of the area - Dun Laoghaire Rathdown County Council.
Enniskerry Local Area Plan, 2009-2016	Plan for the proper planning and sustainable development of the area - Wicklow County Council.
Tallaght Town Centre Local Area Plan, 2006-2012	Plan for the proper planning and sustainable development of the area – South Dublin County Council.
Rathmines Local Action Plan 2009	Plan for the proper planning and sustainable development of the area – Dublin City Council.
A Vision for Dublin Bay	An integrated economic, cultural and social vision for sustainable development – Dublin City Council
Dublin Docklands Area Master Plan, 2003-2008	Overall strategy for the proper planning and sustainable development of the area – Dublin Docklands Development Authority.

1.4.3 Flood risk and the Water Framework Directive

The River Basin Management Plan (RBMP) for the Eastern River Basin District (ERBD), adopted July 2010, sets out a series of objectives and measures for the river, lake, estuarine, coastal and groundwater water bodies of the district, of which the Dodder Catchment forms a part. The Eastern RBMP was prepared to meet the requirements of the EU Water Framework Directive (2000/60/EC) and will be subject to a six-yearly review cycle.

The RBMP is relevant to the Dodder Catchment FRMP, and its SEA, as it sets specific standards for the maintenance and improvement of the ecological (including the supporting habitat) and chemical water quality of the water bodies of the Dodder Catchment within a defined timescale, the main target date for achieving these objectives being 2015. These requirements present both constraints and opportunities for flood risk management as the actions recommended within the FRMP must, as a minimum, not prevent the achievement of the required WFD standards

2 INVOLVING EXTERNAL PARTIES

This chapter of the Dodder Catchment FRMP summarises the activities undertaken during the study to engage with stakeholders and the public.

2.1 OVERVIEW

The involvement of external parties has been essential in the development of the Dodder Catchment FRMP and associated SEA. Throughout the Dodder CFRAM Study, it was important to both meet statutory requirements for consultation with relevant parties; and to ensure that the knowledge, experience and views of stakeholders and the general public were taken into account throughout the development of the FRMP.

2.2 PROVISION OF INFORMATION

It has been essential to ensure that information relating to the study was made available to stakeholders and the general public throughout its development. This has been achieved by:

- The creation and maintenance of a dedicated Dodder CFRAM Study webpage on Dublin City Council's website

  http://www.dublincity.ie/WaterWasteEnvironment/waterprojects/Pages/RiverDodderCatchmentFloodRiskAssessmentManagementStudy.aspx

- The provision of a dedicated email address dodder@rpsgroup.com enabling direct communication with the project team;

- Progress reports and study updates regularly published on the project webpage; and

- All publicly available project technical reports published on the project webpage including, to date, the Inception Report (RPS 2007), the SEA Scoping Report (RPS, 2008) the Hydrology Report (RPS, 2008), the Hydraulic Analysis Report (RPS 2010), the draft FRMP, draft flood hazard and risk mapping, the SEA Environmental Report, and the Natura Impact Statement.

In addition, opportunities to consult with members of the public also arose during channel survey works and technical visits around the catchment by the project team, and these were generally informative and useful.

2.3 STAKEHOLDER CONSULTATION

From the beginning of the study in 2007, a range of statutory, non-statutory and local organisations were identified as stakeholders and were invited to get involved in the development and future implementation of the Dodder Catchment FRMP.

These stakeholders included:

- Key operating authorities in the catchment such as engineers and planners from Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council;

- Environmental bodies;
- Government departments and agencies;
- Local political representatives;
- Non-governmental organisations; and
- Local business and industry representatives.

A list of the stakeholders involved in the Dodder CFRAM Study is included in Appendix A.

Opportunities provided to interested stakeholders to participate in the development of the FRMP and its SEA included:

- Issue of an introductory information to all potentially interested parties seeking data and their views on the key issues within the Dodder Catchment;
- Individual meetings with stakeholders as needed throughout the study to discuss available data; identify key constraints and opportunities and relationships with other relevant plans and strategies; and review key outputs such as the draft flood maps;
- A key stakeholder workshop held in January 2008 to discuss progress and seek feedback on the developing outputs of the study;
- Invitations to comment on key project outputs such as the draft Dodder Catchment FRMP and mapping, the SEA Scoping and Environmental Reports, and the Natura Impacts Statement; and
- Attendance and presentations at relevant conferences and forums such as the Irish National Hydrology Conference

All feedback and comments received from these consultation and engagement activities have contributed to the development and outcomes of the Dodder Catchment FRMP and its SEA.

2.4 PUBLIC CONSULTATION

To ensure that the general public was made aware of the study, and had sufficient opportunity to express their views and comment on its draft outputs, a series of public information and consultation days were held at key locations around the catchment in June/July 2010 when the draft flood maps and preliminary flood risk management options were presented.

Three events were held (Table 2-1). The events were well-publicised in the national and local media and advertised locally.

Table 2-1 Public Information Days 2010

Date	Venue
Wednesday 30th June from 3pm to 8pm	South Dublin County Council's Tallaght Library
Thursday 1st July from 3pm to 8pm	Dublin City Council's main foyer in Civic Offices, Wood Quay
Wednesday 28th July from 3pm to 8pm	Wilfield / Guilford Conference Suite, Mount Herbert Hotel, Herbert Road, Sandymount, Dublin 4

To follow up the events in 2010, the draft flood maps were also made available for comment on the project webpage. The information obtained from this process has informed the finalisation of the flood maps for the catchment and the development of the FRMP and its SEA.

The consultation on the draft Dodder Catchment FRMP, and accompanying SEA Environmental Report and Natura Impact Statement, was the most significant opportunity for the general public to influence the content of the Dodder Catchment FRMP. These and supporting documents were available on the Dodder CFRAM Study webpage and in hard copy at the following Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council offices throughout the catchment (Civic Offices, Wood Quay, Dublin 8; County Hall, Marine Road, Dun Laoghaire, County Dublin; County Hall, Tallaght, Dublin 24) between 6th March 2012 and 8th June 2012. Consultees were invited to comment in writing either by letter or email.

Following completion of the 12 week consultation period, all responses received regarding the draft Dodder Catchment FRMP and its SEA Environmental Report and Natura Impact Statement were considered during the finalisation of the Dodder Catchment FRMP. The influence of consultation and environmental considerations on the plan finalisation process is summarised in the SEA Statement.

This final Dodder Catchment FRMP document, this document, and associated mapping and SEA Statement, were made available from DATE to DATE in hard copy at the following Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council offices throughout the catchment (Civic Offices, Wood Quay, Dublin 8; County Hall, Marine Road, Dun Laoghaire, County Dublin; County Hall, Tallaght, Dublin 24). They are also available to on the Dodder CFRAM Study webpage on the Dublin City Council website. Notifcation was published in XX newspapers on DATE.

3 CATCHMENT OVERVIEW

This chapter of the Dodder Catchment FRMP summarises the Dodder catchment's characteristics, explaining how these influence flows within its watercourses and floodplains, and describing how these characteristics together with records of rainfall, river level and tides were analysed to identify current catchment response. The influence of possible future changes within the catchment (in land use, land management and climate change) on flows is also assessed.

3.1 EXTENT OF THE DODDER CATCHMENT

The River Dodder is one of Dublin's best known and most important rivers. Figure 3.1 shows the Dodder catchment which stretches from Ringsend in Dublin City, west as far as Tallaght and southwest as far as Kippure in the Dublin Mountains.

The Dodder collects rainwater from a 12,081 hectare (120.8 km^2) catchment and discharges to the Liffey Estuary. After it rises at Kippure Mountain, above Glenasmole, it flows through bogland, light forest and agricultural land before entering urban Dublin. It flows through the suburban areas of Tallaght and Rathfarnham and through the city areas of Donnybrook and Ballsbridge before discharging into the Liffey Estuary at Ringsend. The lower section of the river is tidal up to the weir upstream of Ballsbridge.

The upper portion of the catchment from the source to Old Bawn in Tallaght includes the two Bohernabreena Reservoirs (Upper and Lower) and their spillways which are an integral part of the water supply to Dublin. This section is mainly rural while the lower catchment is already heavily developed with residential and industrial land uses.

There are five main tributaries whose sub-catchments drain into the River Dodder; the Tallaght Stream, the Owendoher, the Whitechurch, the Little Dargle and the Dundrum Slang, all of which are heavily urbanised streams

The Dodder's surrounding parklands are an extremely important amenity to Dublin and the river is widely used by fishermen and a variety of sporting and recreational interests over its 27 km long course.

3.2 TOPOGRAPHY, GEOLOGY, SOILS AND GROUNDWATER

3.2.1 Topography

Topography has a direct impact on catchment response to rainfall. Steeper slopes tend to cause a faster speed of flow, both below and over the ground surface. Topography also influences the extent of flooding as in flat areas floodwaters can spread over much larger extents than in steep narrow valleys.

Dodder Main Channel: The River Dodder rises at Kippure in the Dublin Mountains at an elevation of 753.8 mOD and flows in a north-westerly direction towards Tallaght where it changes course to a north-easterly direction and continues down through Rathfarnham, Milltown, Donnybrook and Ballsbridge before entering the Liffey estuary at Ringsend. The total length of the river is approximately 27 km.

The Bohernabreena reservoir system is located in the upper reaches of the River Dodder at approximately 180 mOD. Approximately 28.0 km^2 of the River Dodder catchment drains to the reservoirs while the remaining 92.8 km^2 drains directly to the river downstream of the lower reservoir spillway. The stretch of river upstream of the Lower Reservoir spillway is approximately 9.5 km in length and falls at an average gradient of 1 in 15. The upper catchment topography is predominantly rural and mountainous in nature.

The stretch of river downstream of the reservoirs is approximately 17.5 km in length and falls at an average gradient of 1 in 115. The lower reaches of the river are highly modified and canalised with walled banks in some areas, however in the newer urban areas there are large areas of parkland and riverside walks.

Below the weir at Ballsbridge, approximately 2 km from the confluence with the River Liffey, the River Dodder is considered tidal.

Tallaght Stream: The Tallaght Stream rises at Knockannavea in the Dublin Mountains, south of Tallaght, at an elevation of approximately 390 mOD. It flows in a northerly direction towards Jobstown and then flows east through Tallaght where it joins the River Dodder Main Channel. The stream is approximately 8.2 km in length, falls at an average gradient of 1 in 25 and drains a catchment of approximately 12.9 km^2.

Owendoher: The Owendoher rises at Kilakee in the Dublin Mountains, at an elevation of approximately 570 mOD. It flows in a northerly direction through Edmondstown and Ballyboden before joining the River Dodder Main Channel at Bushy Park in Rathfarnham. The stream is approximately 9.9 km in length, falls at an average gradient of 1 in 19 and drains a catchment of approximately 13.3 km^2.

Whitechurch: The Whitechurch is a tributary of the Owendoher and rises between Tibradden and Kilmashogue Mountains at an elevation of approximately 480 mOD. It flows in a northerly direction through Marley Park and St. Enda’s Park and onto Willbrook where it meets the Owendoher. The stream is approximately 7.7 km in length, falls at an average gradient of 1 in 18 and drains a catchment of approximately 8.9 km^2.

Little Dargle: The Little Dargle rises at Two Rock Mountain at an elevation of approximately 520 mOD. It flows in a northerly direction through Ballinteer and Churchtown before joining the River Dodder Main Channel in Rathfarnham. The stream is approximately 8.5 km in length, falls at an average gradient of 1 in 17 and drains a catchment of approximately 8.3 km^2.

Dundrum Slang: The Dundrum Slang rises at Three Rock Mountain at an elevation of approximately 430 mOD. It flows in a northerly direction through Dundrum and Windy Arbour before joining the River Dodder Main Channel in Milltown. The stream is approximately 8 km in length, falls at an average gradient of 1 in 20 and drains a catchment of approximately 9.5 km^2.

Bohernabreena Reservoir System: The Bohernabreena reservoir system was constructed between 1883 and 1886 to serve as a water supply to Dublin City. It consists of two separate reservoirs, known as the Upper and Lower reservoirs.

Upper Reservoir: The Upper Reservoir has a surface area of 0.23 km^2, a maximum capacity of 1.56×10^6 m^3 and a catchment area of approximately 7.0 km^2. The waters from this catchment are clear and suitable for drinking and the reservoir is therefore used for water supply purposes. The water level in this reservoir depends on natural inflow and drinking water demands and it is not used for water storage during storm events.

Lower Reservoir: The Lower Reservoir has a surface area of 0.12 km^2, a maximum capacity of 0.5×10^6 m^3 and a catchment area of approximately 21.0 km^2. This reservoir can be drawn down to provide additional water storage preceding an expected storm event. A 1600 mm diameter valve at the Lower Reservoir outlet controls the water level and can lower it by up to 4 m from a top water level of 148.3 m (outlet weir crest level) to 144.3 mOD.

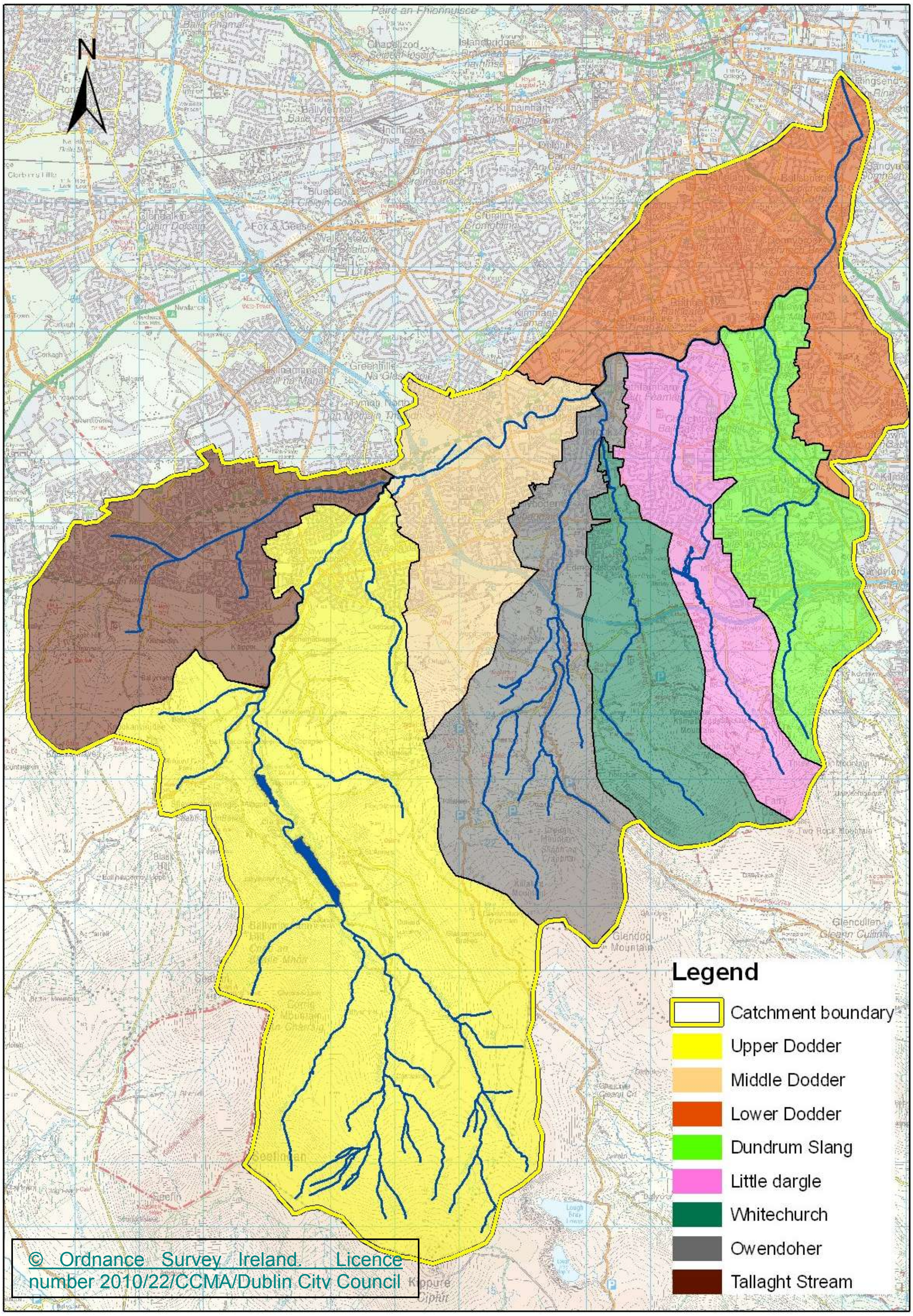


Figure 3-1 Map of the Dodder catchment area

3.2.2 Geology, soils and groundwater

The impact of geology and soils on catchment response is determined by the permeability of rocks and soils overlying the catchment. If the permeability is high then a greater proportion of rainfall will infiltrate into the ground. This reduces the amount of surface runoff that reaches rivers and reduces peak flows by delaying the transport of water from the catchment into the watercourses. In addition if the ground is wet at the start of a rainfall event more water will enter watercourses as opposed to being stored in the soil.

Bedrock geology - The upper reaches of the Dodder catchment and the area surrounding the reservoirs consists of granite and sandstone while the lower reaches of the catchment mostly consist of carboniferous limestone.

Quaternary geology - GSI mapping indicates that the main soil type of the River Dodder's upper catchment is peat. At Kippure Mountain bedrock exists within 1 m of the surface, there are deposits of alluvial till (derived from granite and undifferentiated glaciofluvial gravel) as far as the Upper reservoir at Bohernabreena. Alluvium deposits exist between deposits of till derived from Lower Palaeozoic limestone and undifferentiated glaciofluvial gravel throughout the catchment. Along the more urbanised areas from Oldbawn to Ringsend the river is within deposits of alluvium, alluvial gravel and undifferentiated glaciofluvial gravel and lies between areas of made ground and tills derived from Lower Carboniferous limestone.

Soils - The soils of the upper catchment consist of peaty podzols, acid brown earths and lithosols. The lower catchment is mainly manmade ground with some brown earths and surface water gleys along the river banks.

Groundwater is water located in the soils and rocks beneath the ground surface. Groundwater is fed or recharged mainly from precipitation which soaks into the soil. In the soil some of the water will be taken up by plants and some will infiltrate to become groundwater. The upper level of this groundwater is known as the water table. Groundwater will flow from where it has infiltrated to a point of discharge. This is usually a spring, a river or the sea. Groundwater provides a vital role supporting wetlands, streams and rivers as much of their flow is made up of discharging groundwater.

The geological make-up of the subsurface will impact on the movement of the groundwater. Permeability is a measure of how fast water will flow through connected openings in soil or rock. Low permeability refers to soil or rock that restricts the movement of water through it. Permeable layers (such as sands and gravels) contain fine holes that allow water to flow. Such permeable formations that contain groundwater are known as aquifers.

The upper reaches of the Dodder catchment and the area surrounding the reservoirs are predominantly granite and sandstone which is unproductive for groundwater supply. The carboniferous limestone underlying the lower reaches of the catchment is classified as moderately productive only in local zones. Consequently, the contribution of groundwater to flooding is not significant in the Dodder catchment.

3.3 LAND USE AND LAND MANAGEMENT

Land use and land management practice also influence catchment response to rainfall. Vegetation, for example, can change the amounts of rainfall and snowmelt reaching the main channels by intercepting and storing precipitation, or through shading (which slows down the rate of melting in snow), or through transpiration in plants (uptake of water and its evaporation to the atmosphere from leaf surfaces).

The type of vegetation and season are important factors; in summer, broadleaved trees will have greater interception and transpiration potential than conifers, but conifers will provide more shading in winter. Grassland has much less potential for interception and transpiration, although it does have an important role in soil conservation. These patterns of interception, shading and transpiration in different plant groups are also influenced by land management practices such as farming and forestry crop management cycles.

Consequently, rural land has a runoff rate dependent on the particular use to which it is put and its land management practices. Important rural factors include agricultural uses, land drainage, vegetation type and cover, soil management etc. Thus, land use and land management can influence flood risk by affecting the amount and rate of rainfall reaching the river channel. It also affects a catchment's sensitivity to flooding.

Conversely, urban land uses typically have hard surfaces which drain quickly causing rapid runoff into drains and sewers and receiving watercourses. Factors in urban areas are also very sensitive to flooding with small amounts of flooding potentially causing significant damages and risks to people.

The upper reaches of the Dodder catchment are mostly rural consisting of peat bogs, mixed forest and land occupied by agriculture and natural vegetation. Whilst the lower catchment is already heavily developed with residential and industrial land uses. The various land uses within the catchment, based on data from 2000, is shown on Figure 3-2.

Future Land Use and Land Management Changes: The most likely future land use scenario for the Dodder catchment was assessed to determine the likely consequences for catchment response. In future years it is expected that urban land cover will continue to grow with population growth while the pattern of agricultural activities (including reforestation which is expected to continue to increase in order to meet Government targets for forestry cover) will vary in line with EU Common Agricultural Policy reform.

As part of the Greater Dublin Strategic Drainage Study (GDSDS) (*Dublin Drainage Consultancy, 2002*), a comprehensive Population and Land Use Study was undertaken. One element of this land use study involved the assessment of the 2002 development situation in the Greater Dublin Area. Given the time lapse since the preparation of the GDSDS Population and Land Use Study and also given the level of development in the Greater Dublin Area in the intervening years, the GDSDS current development land use figures were revisited for this CFRAM Study projecting forward to 2031.

The update concluded that the most likely future land use scenario for the Dodder catchment will see development in the River Dodder "urban" sub-catchments continue until it is capped due to a lack of available lands. It is not expected that any future development will occur in the "rural" sub-catchments above 160 mOD height, as it is assumed water supply restrictions would prevent major development above this elevation which is also seen as a limit in terms of landscaping and conservation.

In addition to urbanisation, the assessment of the future land-use scenarios in the Dodder catchment has also considered the sensitivity of the catchment's response to land management policies assessing the effect of implementing sustainable drainage systems (SuDS), as recommended in the GDSDS, in the catchment.

The resulting changes in flooding in the catchment are explained in Section 4.

3.4 HYDROLOGY AND TIDAL CONDITIONS

Hydrology concerns the occurrence and movement of water in the environment. The effects of surface water hydrology, which looks at the relationship between rainfall on the land surface and runoff into or flow in watercourses (streams, rivers and lakes), is of particular interest for assessing fluvial flood risk.

3.4.1 Rainfall and hydrometric data

The climate of the Dodder catchment is generally temperate. Annual air temperatures average around 9^{o}C, with 4 hours of sunshine per day. Prevailing weather patterns generally move from the southwest to the northeast. Rainfall patterns are typical of what might be expected in terms of wind and topography. The area experiences relatively high precipitation for a catchment on the east coast of Ireland, due to the elevated topography of the upper catchment. Annual precipitation within the Dodder catchment varies with the upland Dublin mountains receiving over 2000 mm rainfall per year, whereas the lower parts of the catchment receive around 1000 mm per year.

The best method of assessing the frequency and size of a flood is through analysis of historical records of river levels and flows and rainfall events. The EPA operate three calibrated water level gauging stations in the Dodder CFRAM Study area. Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council operate six rainfall gauges in the Dodder CFRAM Study area and Met Éireann operate a further forty one daily and one hourly rainfall gauges in and surrounding the catchment. The locations of the level and rainfall gauges which have been used in this CFRAM Study are shown in Figure 3-3.

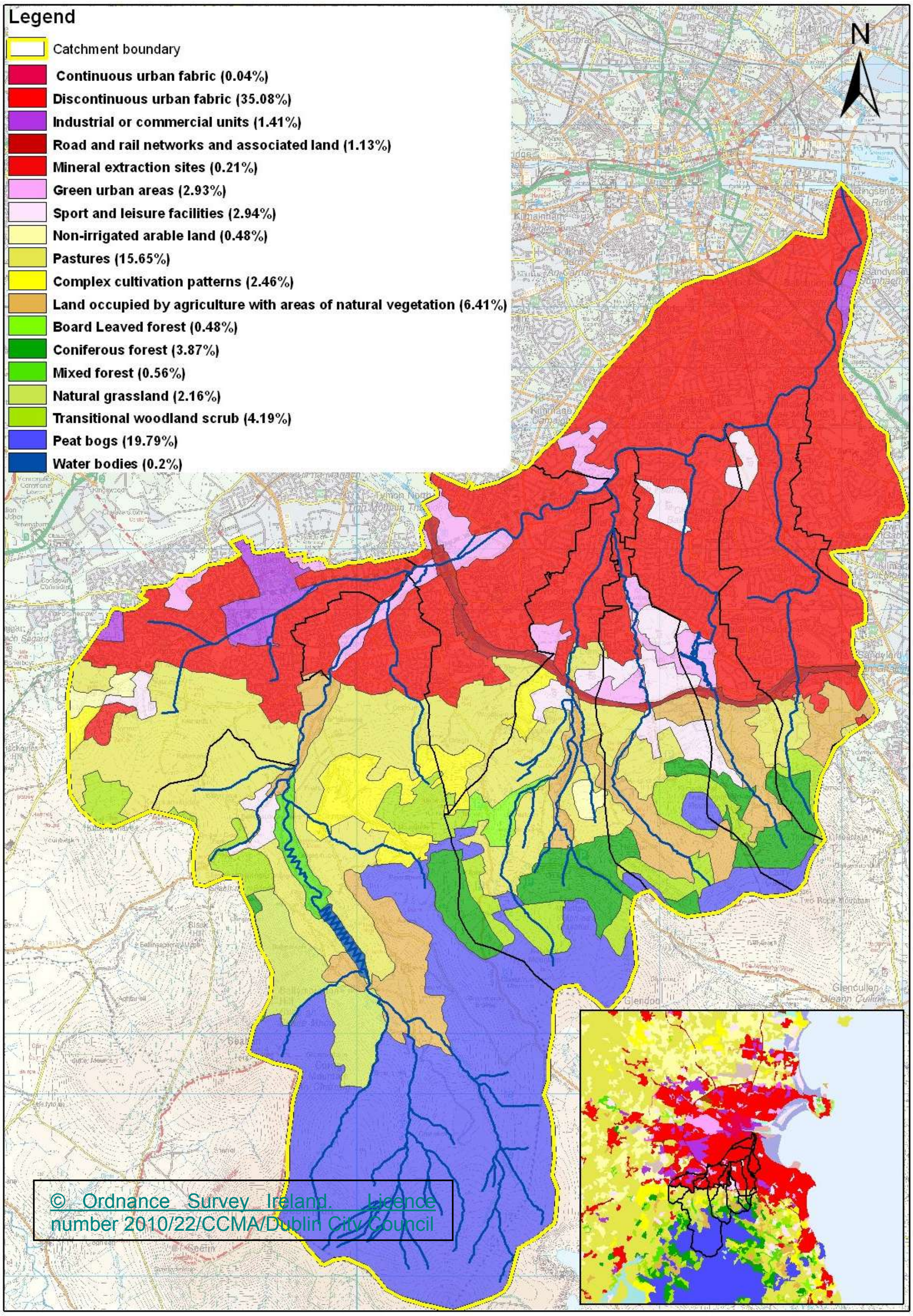


Figure 3-2 Land use within the catchment (Source: EPA Corine land cover database 2000)

Future Climate Change: Rainfall and hydrometric data together with hydrological models have been used to determine the flow conditions in the River Dodder and its tributaries during the current day. Future scenarios, which take account of possible climate change impacts, have been assessed by applying predictions to rainfall volumes and seasonal patterns and catchment characteristics such as evaporation.

Met Éireann data from three climate change models was used to estimate the future increase in precipitation across the Dodder Catchment and assess how climate change may effect river flows. To accommodate seasonal effects, summer rainfall would be expected to change from mostly frontal rainfall to convective rainfall with longer drier periods occurring. On the other hand it was assumed that the number of extreme rainfall events (>20mm/day) would increase and in particular summer rainfall would become significantly heavier (concentrated). New evaporation rates were estimated based on a 3°C average temperature increase proposed in the Community Climate Change Consortium for Ireland (C4I) Project. The resulting changes in flooding in the catchment are explained in Section 4.

3.4.2 Tides and surge

Tides are the rising and falling of the earth's ocean surface and are mainly caused by the gravitational forces of the moon and sun on the earth's oceans. The rising and falling of the ocean surface changes the depth of marine and estuarine water bodies and produces oscillating currents known as tidal streams. The oscillation of these tidal streams occurs in Ireland on a twice-daily basis in response to the semi-diurnal tidal cycle. The tidal cycle is also influenced by other factors such as meteorological conditions e.g. wind and barometric pressure, which can raise or lower the normal or astronomical sea levels. During periods of low barometric pressure, usually associated with deep atmospheric depressions, a phenomenon called storm surge occurs, whereby normal sea levels are artificially raised.

Coastal water levels are recorded at a number of locations in Dublin. Long term observations are available from Dublin City Council and Dublin Port. Coastal water levels were recorded at Poolbeg Lighthouse until the gauge was moved to North Wall Quay and recently an additional gauge has been installed at Kish Bank Lighthouse. The locations of the tide gauges are also shown in Figure 3-3.

Tidal data for the period January 1980 to December 2004 have been analysed for the Dodder CFRAM Study. In addition coastal water level datasets are also available from the OPW through the Irish Coastal Protection Strategy Study and from Dublin City Council for the Dublin Coastal Flooding Protection Project.

In addition to the above astronomical tide levels, storm surges can propagate into Dublin Bay causing these levels to be further elevated. Storm surges of 0.5 m and above occur regularly in the Bay. However, these generally only give rise to concern when they coincide with periods of high spring tides.

The likelihood of the combination of such events is referred to as probability of joint occurrence or joint probability. Typically storm surges are associated with depressions tracking in from the Atlantic over Ireland associated with rainfall and strong winds as well as sudden changes in wind direction. One very good example is the October 2004 storm surge event, which gave large water levels along the south coast and Wexford area and, combined with large rainfall, gave rise to significant flooding in southern parts of Ireland. In Dublin the total rainfall on the 27-28 October 2004 reached a value of over 100 mm (with most rain falling around the time when wind speeds peaked); this coincided with the third highest tide recorded in the Liffey Estuary.

Future Climate Change: Again these datasets have been used to determine the downstream conditions in the lower tidal stretch of the River Dodder both the current day and, by applying appropriate models and assumptions, to determine future scenarios which take account of possible climate change impacts.

As a result of the changing global climate it would be expected that Ireland will in future experience a milder but wetter climate with the frequency of storms shifting slightly further north and thus decreasing. However due to the increased temperature difference between the arctic waters and Europe, it is assumed that the intensity of storms will increase and thus more extreme surges will be experienced. In addition, Ireland's land level would change relative to surrounding water due to changes in climate after the last ice age. The resulting changes in flooding in the catchment are explained in Section 4.

3.5 SUMMARY OF DODDER CATCHMENT RESPONSE

Generally, fluvial flooding in the Dodder catchment is as a result of heavy rainfall in the Dublin mountains causing large volumes of water to pass down through the Dodder River. The Bohernabreena reservoirs provide some flood storage and therefore reduce peak downstream river flow, however, as more tributaries and urbanised areas alongside the main channel join, the flow in the River Dodder increases again downstream.

Flows within the small, steep tributaries, particularly in the upper parts of the Dodder catchment and in urbanised areas can increase fairly rapidly, reaching peak flows within three hours of the rainfall starting, for example along the Whitechurch tributary. The main channel itself reaches peak flow within five hours of rainfall starting.

The River Dodder is renowned for its quick catchment response and flashy characteristics. Factors contributing to this flashy nature include;

- Large rainfall events in the mountainous part of the river catchment;

- Large catchment area compared to river length;

- Geology and drainage of upper catchment together with urbanisation of the lower catchment results in a high proportion of precipitation runoff.

The influence of tidal and storm surge levels in the Dodder catchment is confined to the lower reaches of the Dodder downstream of the Ballsbridge area.

The key factors that would influence change in the Dodder catchment's future flood response are changes in land use and management and climate change.

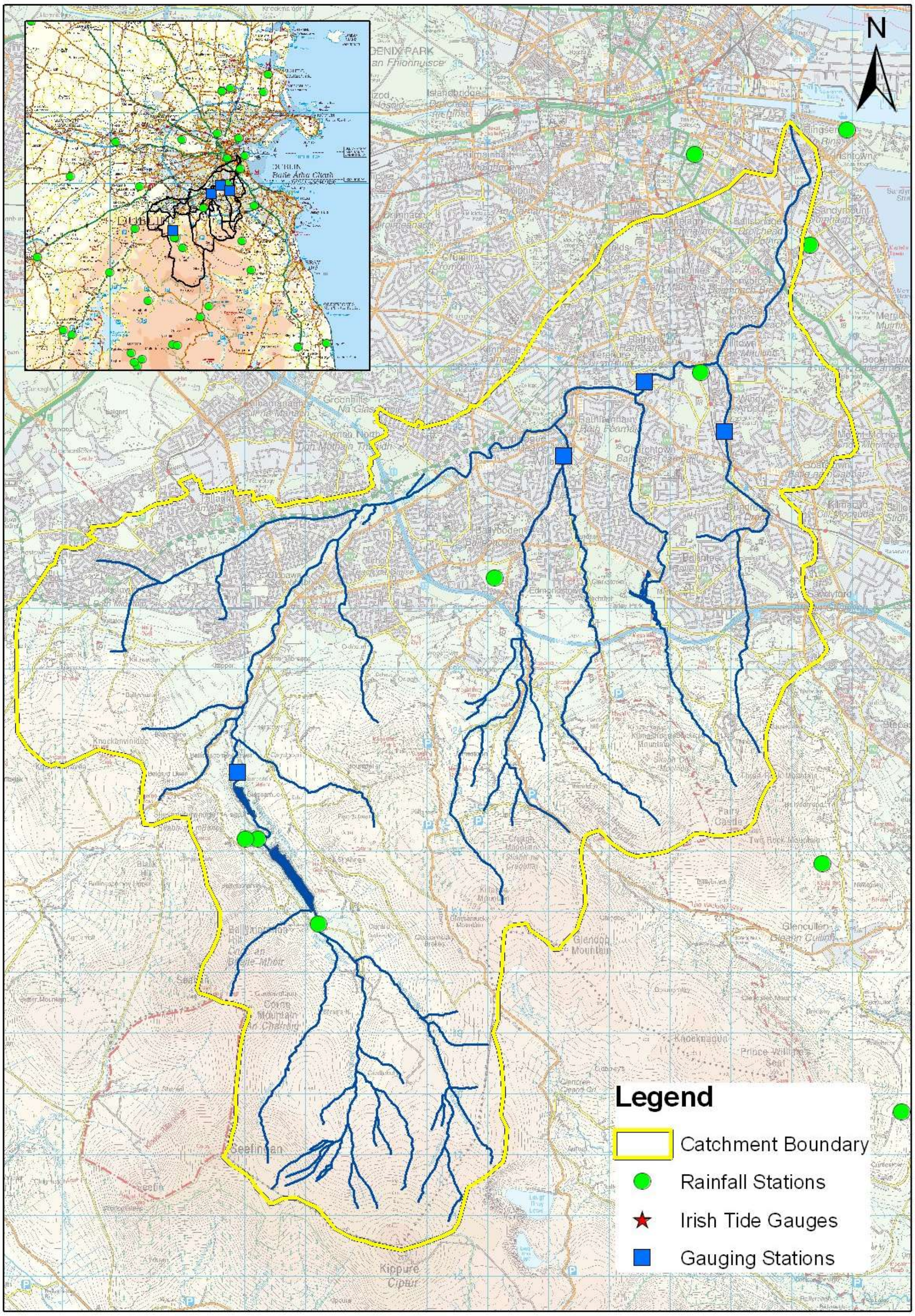


Figure 3-3 Location of gauges within the Dodder catchment

4 FLOODING IN THE CATCHMENT

This chapter of the Dodder Catchment FRMP summarises historic flooding in the Dodder Catchment, identifies the main sources and mechanisms of flooding, describing how computer modelling was used to identify current and future flood hazard.

The River Dodder has a history of flooding and is known as a "flashy" river with a quick response to rainstorms. This is largely due to its source being in the Dublin mountains which provides it with a steep gradient and periods of high rainfall.

In the last century it has overflowed its banks on numerous occasions causing damage to adjacent properties. A number of areas have experienced river and/or tidal flooding within the Dodder catchment. These flooding problems mainly cause damage to public roads and properties also flooding parkland in the urban areas of the Dodder catchment and result from both fluvial (river) and tidal sources. There is also a degree of rural flooding in the upper catchment resulting from fluvial flooding.

One of the most severe floods in recent times occurred on 25 August 1986 (Hurricane Charlie) with well over 300 properties affected by the flooding, leading to much human misery and anxiety. During this storm the reservoir dams in Bohernabreena were within millimetres of being overtopped. To secure these dams, new spillways have since been constructed at the Bohernabreena reservoirs to cater for the "Probable Maximum Flood" (which is 383 m^3/s at Bohernabreena).

Another notable recent flooding event occurred on 1 February 2002 when there was a significant high tide. Over 600 properties were flooded on the lower Dodder downstream of Lansdowne Road Bridge during this event.

The severe flood event of 23-24 October 2011 caused widespread flooding throughout the Dodder catchment.

In order to increase the level of protection on the River Dodder, the following work was carried out to the most vulnerable areas:

- In 1986 flood walls and embankments were constructed at Donnybrook and along Anglesea Road;
- In 2003 work was started on the Dodder Estuary at Fitzwilliam Quay and Stella Gardens;
- In 2006 work was completed on the Bohernabreena Reservoir Spillways;
- A pipe was submerged beneath the river which had originally crossed it at Beatty's Cottage, Beatty's Avenue;
- Ongoing Lower Dodder Flood Alleviation Work 2007 – 2010.

There is some evidence of seasonality of flooding in the Dodder catchment (fluvial and tidal). The majority of the floods have occurred during the winter season, however the most severe fluvial flooding occurred during Hurricane Charlie which was a summer event (August 1986).

4.1 SOURCES OF FLOODING

River (fluvial) flooding is caused by the channel system being unable to convey the quantity of rainfall draining into it from the surrounding catchment. This quantity is a function of catchment response (Section 3), which is influenced by factors such as land use and urbanisation. During extreme events natural rivers occupy not only their channel but also their floodplain. A channel's capacity is influenced by its size, shape, slope and roughness as well the height of the banks or defences on either side of it, the restrictions posed by bridges and other structures, and the operation of pumps, gates and weirs. The duration of a fluvial flood is dependent on the intensity and duration of the rainfall event. Runoff from sustained rainfall events tends to result in longer duration flood events. Runoff from intense thunderstorms results in short duration flash floods.

Tidal flooding is the inundation of low lying floodplains by tides. Tidal flooding is influenced by the tidal cycle (particularly seasonal high tides such driven by the spring neap tide cycles), storm surges (caused by low pressure weather systems which force the water level to rise higher than the normal sea level) and to a lesser degree wind driven wave action (which is not explicitly assessed in this Study). Extreme conditions leading to tidal flooding are most commonly a result of a combination of these influences. For example, the widespread flooding around Dublin Bay in February 2002 was caused by a high tide and a deep atmospheric low pressure combining to create a storm surge which flooded low lying areas along the east coast of Ireland. The duration of tidal flooding is limited by the cycle of the tides where drainage is available.

Apart from fluvial and tidal flood hazards, smaller scale flood hazard can arise from surface water runoff/rainfall flooding areas where water cannot escape due to high river or tide levels or from high groundwater levels. Flooding can be exacerbated by under-capacity bridges and culverts and by debris causing blockages in some areas. These other sources of flooding are difficult to predict, are generally more localised in nature and are not the primary sources of flood hazard in the Dodder catchment.

This CFRAM Study focuses on the effects of fluvial and tidal flooding which represent the main flood hazards within the Dodder catchment. The Floods Directive requires consideration of pluvial flooding, which is currently being studied at national level by the OPW and in Dublin City by the FloodResilienCity (FRC) project for which Dublin City Council is a partner organisation, The Floods Directive also requires consideration of groundwater flooding, which is not a significant flooding source in the Dodder catchment. These additional flooding aspects will be addressed during a Floods Directive plan compliance review that will be undertaken by the Eastern CFRAM Study before the Dodder Catchment FRMP is incorporated into the Liffey FRMP and reported to the EU in 2015.

4.2 FLOOD EXTENTS, PROBABILITY, DEPTH, VELOCITY AND HAZARD

Flood extents describe the area where floodwater will most likely spread to during an event. This is influenced by the floodplain's topography and the quantity of water in it. The quantity of water in the floodplain depends on the magnitude of the flood event (quantified as its probability of occurring in any year) and the source of flooding taking place.

Different magnitudes of flooding have different likelihoods (or *probabilities*) of occurring as is defined by an event's annual exceedance probability (AEP). This is the likelihood of a particular magnitude flood occurring or being exceeded in any given year. Thus, a 1% AEP event describes a flood event which has a 1% (or 1 in 100) chance of occurring or being exceeded in any given year. Flood events with a lower probability of occurrence result in more extreme flooding. For example, a 1% AEP flood event will result in more flooding than a 50% AEP event. It should be noted that the likelihood of a flood event occurring in any given year, whatever its probability, is independent of the time since the last flood of similar magnitude, for example, a 0.5% (or 1 in 50 year) event and a 1% event could, in theory, occur in the same year.

Floodwater depth and velocity combine to describe flood *hazard*. These elements are important as they have a direct effect on flood risk (determined as, potential for loss of life and damage to the economy (property, infrastructure), society, the environment and cultural heritage)

The depth of flood waters is determined by a number of factors including the magnitude of the flood event, the width and shape of the channel and floodplain, land use, and the presence of structures. Deeper flood waters will accumulate where the speed of flow is reduced or restricted due the roughness of the ground surface and the presence of structures. Depressions or ‘bowls’ in the floodplain will cause deep pools of floodwaters to build up.

The velocity of flood flow in a river channel and its valley is controlled by gradient, size, shape and roughness, restrictions posed by bridges and other structures and the operation of pumps, gates and weirs. The shape of the seabed determines the velocity of flood flow in a bay which in turn determines the velocity of floodplain inundation in a lower catchment.

Using this flood hazard information, the number of properties prone to flooding can be estimated, which can be used to measure the social impact of flooding, what the economic damage to property might be and how the environment and cultural heritage is affected (for example, impacts on designated sites) as detailed in Section 5.

4.3 FLOOD MODELLING – CURRENT AND FUTURE SCENARIOS

Computer modelling has been used to replicate catchment flood response and flood mechanisms in order to help understand the extent and probability of fluvial and tidal flooding hazard specific to the Dodder catchment. Flood mechanisms describe the primary cause of a particular area being inundated; these include structures that control flow (such as weirs, culverts and bridges) as well as overtopping of low-lying river banks or existing defences and insufficient channel capacity.

Computer models which represent the catchment’s rivers, floodplains and control structures were developed to assess current and future flood hazard for this CFRAM Study. To facilitate this assessment, the Dodder catchment was represented as eight river sub-models which were linked together to exchange data during simulations:

- the Dodder main channel was split into the three sub-models:
    - the Dodder Upper (from the Bohernabreena Reservoir system to Firhouse Weir beside the M50);
    - the Dodder Middle (from Firhouse Weir to Rathfarmham Road Bridge); and
    - the Dodder Lower (from Rathfarmham to the River Liffey confluence in Ringsend); and
- each of the five main tributaries were also modelled:
    - Tallaght Stream;

- Owendoher;
- Whitechurch;
- Little Dargle;
- Dundrum Slang (initially developed as the Dundrum Upper, the Dundrum Middle and the Dundrum Lower sub-models due to delivery schedule for ground level information).

Tidal levels controlling water levels in the downstream reaches of the Dodder system were available from modelling undertaken on behalf of the OPW for the Irish Coastal Protection Strategy study.

The extent of each of the river sub-models is illustrated on Figure 4-1 with key statistics summarised in Table 4-1. Further details are available in the Dodder Hydraulics Report which is available via the project webpage (www.dublincity.ie).

Table 4-1 Extent of computer sub-models in the Dodder Catchment

Sub-model	Length km	Control Structures	Cross Sections
Dodder upper	6.1	3 weirs	66
Dodder middle	5.0	2 weirs	62
Dodder lower	7.9	11 weirs and 11 culvert/bridge structures	83
Tallaght Stream	4.7	27 weirs and 11 culvert/bridge structures	95
& tributary	0.6		7
Owendoher Stream	4.1	10 weirs and 16 culvert structures	118
Whitechurch Stream	3.4	4 weirs and 6 culvert/bridge structures	112
Little Dargle	4.2	3 weirs and 5 culvert/bridge structures	35
Dundrum Slang	4.6	3 weirs and 7 culvert/bridge structures	70
& tributary	0.8	1 weir and 2 culvert/bridge structures	22

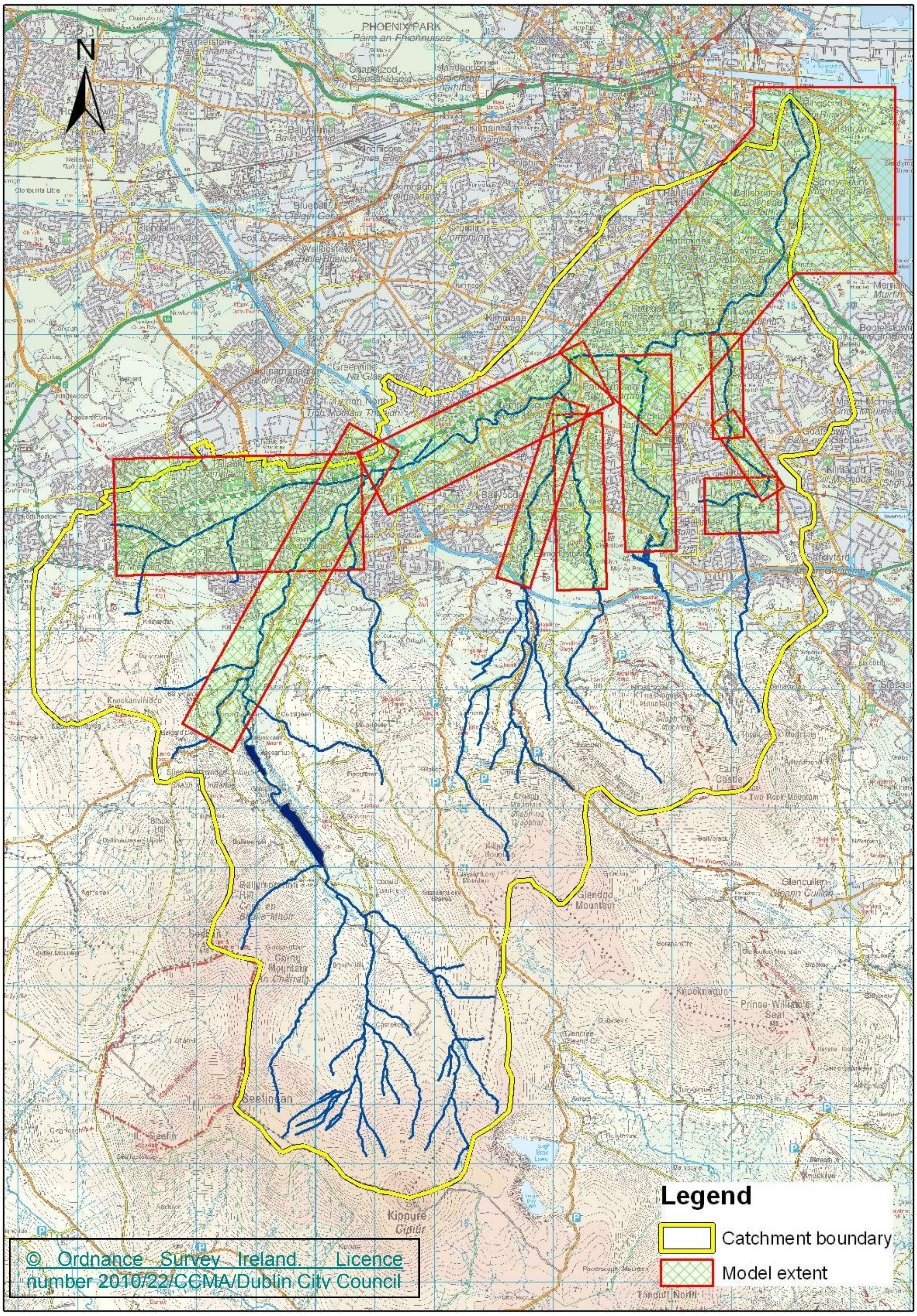


Figure 4-1 Extent of river modelling in the Dodder Catchment

The river models were built using detailed river channel and ground level information, to simulate estimated river flows and tidal levels for a range of event probabilities. Channel topographical surveys, structure surveys and a defence asset surveys were undertaken as part of the Dodder CFRAM Study, providing data to input to these models. In addition LiDAR data, provided by the OPW, was input to the model of the Dodder floodplains.

The models calculate where the water would flow based on the ground levels and in doing so simulate the movement of floodwater determining the extent of flood hazard within the Dodder catchment. The river models provide flood depths and velocities as well as flood extents.

The models also establish how much freeboard (or height difference) there is between the top of defences or river banks and flood water levels. Freeboard is utilised in defence design to allow a factor of safety for any uncertainties in water levels. In Ireland, flood defences are generally designed to provide 300 mm freeboard (hard defences) and 500 mm freeboard (embankments) for 1% AEP river or 0.5% AEP tidal flood events.

The models were calibrated. This is a process of comparing model results with records from historic flood events and adjusting model parameters within set ranges to ensure that model results correlate well recorded events. A key objective was to calibrate the flood extents with previous events such as Hurricane Charlie. Extensive calibration was undertaken using historic data and observations made by the area engineers from Dublin City Council, South Dublin County Council and Dún Laoghaire-Rathdown County Council. Two events that occurred during this CFRAM Study, the flooding along the Whitechurch in 2007 and 2008, and flooding of the main Dodder with low return periods were used to verify the model and in general a good correlation was found. A sensitivity test of the model was also undertaken whereby key input data was altered to see what impact this had on its results in order to highlight the importance of different model parameters (such as flow, grid resolution, roughness factors and development assumptions).

The calibrated Dodder models were used to assess the impact of flooding for future scenarios as well as the current situation. Considering how flood hazard may change in the future helps to set the right policies, strategies and actions to meet the needs of flood risk management for the next 100 years. Social and economic development are major drivers of future flood risk management. Effective and sustainable management can only be achieved through the development and implementation of a range of flood risk management activities that are flexible and adaptable to change in light of the inherent uncertainties.

As described in Section 3.0, future flood hazard in the Dodder catchment is mainly influenced by:

- Climate change: milder wetter winters and increases in intensive rainfall events could increase flows in rivers on a more frequent basis, increase demands on urban drainage networks, and lead to increased occurrence of structure blockages. Sea level rise could mean that higher tides are experienced; this rise, coupled with stormier winters, means the impact of climate change at the coast could be severe in the Dodder catchment,

- Land use change: an increase in urban areas could lead to increased surface water runoff and a more rapid rise in peak flows as the area of impermeable surface increases however the implementation management policies such as SuDS can mitigate such potential changes, and

- Land management practices: change in land management practices (for example agricultural intensification or afforestation) may lead to changes in surface water flows and field runoff, again the implementation management policies such as SuDS can mitigate such potential changes .

The potential flooding impact over the next 100 years has been explored through investigations, and modelling of two future flood hazard scenarios:

- Mid Range Future Scenario (MRFS) representing the more likely estimates of changes by 2100, and

- High End Future Scenario (HEFS) representing more extreme changes in the respective factors by 2100. This considers the future adaptability of flood defence measures but it is worth noting that these factors will not necessarily impact cumulatively.

These future scenario assumptions are summarised in Table 4-2.

Table 4-2 Future Flood Scenario Assumptions

Parameter	Mid Range Future Scenario	High End Future Scenario
Land Use	Future development 2100	Future development 2100
SuDS	Full implementation of SuDs	Full implementation of SuDs
Precipitation	Average of three Met Éireann climate change model predictions	Maximum of three Met Éireann climate change model predictions
Coastal	Irish Coastal Protection Strategy Study medium range surge predictions + 0.5m sea level change	Irish Coastal Protection Strategy Study high end surge predictions + 0.8m sea level change

Whilst there is uncertainty regarding what changes will occur, general trends can be projected over this time period to determine the likely scale of change that would affect flood hazard in the catchment. CFRAM Study will be reviewed every 6 years and will be updated to reflect changing conditions in the Dodder catchment.

A range of annual exceedance probability floods were modelled for current and future scenarios, varying from 50% to 0.1% AEP (1 in 1,000) in any given year.

The modelling considered the joint probability of fluvial events and tidal events. A statistical analysis of rainfall and surge data was undertaken to establish the AEP for extreme rainfall and surge conditions. The correlation between the range of rainfall and surge combinations was analysed. This correlation was applied to the extreme rainfall and surge to provide a 1% AEP (1 in 100) event.

4.4 FLOOD MAPPING AND FLOOD HAZARD DESCRIPTION IN THE DODDER CATCHMENT

Flood maps are one of the main outputs of the Dodder CFRAM Study and are the way in which model results are communicated to end users. The flood maps represent all areas that are likely to be inundated at some point during a flood event. The key types of mapping developed were:

- Flood extent maps – show the estimated area inundated by a flood event of a given annual exceedance probability. These maps also show levels of confidence in the flood extents, plus water levels, flows and defended areas.

- Flood depth maps – illustrate the estimated flood depths for the likely areas inundated by a particular flood event;

- Flood velocity maps – show the likely speed of the flood water for a particular estimated flood event using graduated colours; and

- Flood hazard maps – show the harm or danger which may be experienced by people from a flood event of a given annual exceedance probability, calculated as a function of depth and velocity of flood waters. Flood hazard was defined based on the approach presented in the DEFRA/Environment Agency Research & Development project "Flood Risks to People" FD2320/FD2321 as applied to CFRAM studies nationally.

Flood maps provide valuable information regarding flooding within the catchment for both technical and non-technical users. The maps were used within this study to identify areas that are prone to significant flooding and to inform the development of flood risk management options. These flood maps can also be used, with due regard to their underlying assumptions, to:

- raise awareness of flood hazard to property and life;

- aid flood event response planning and action; and

- inform spatial planning and development management within the floodplain and support the implementation of the Guidelines on the Planning System and Flood Risk Management.

A separately bound volume of draft flood extent, depth, velocity and hazard maps, representing the estimated current scenario and flood extent maps for future flood scenarios, accompanies this Dodder Catchment FRMP. These maps are available online on the Dodder CFRAM Study webpage of the Dublin City Council websites. Example flood depth and hazard maps are shown in Figures 4-2 and 4-3.

Figure 4-2 Example flood depth mapping in the Dodder Catchment

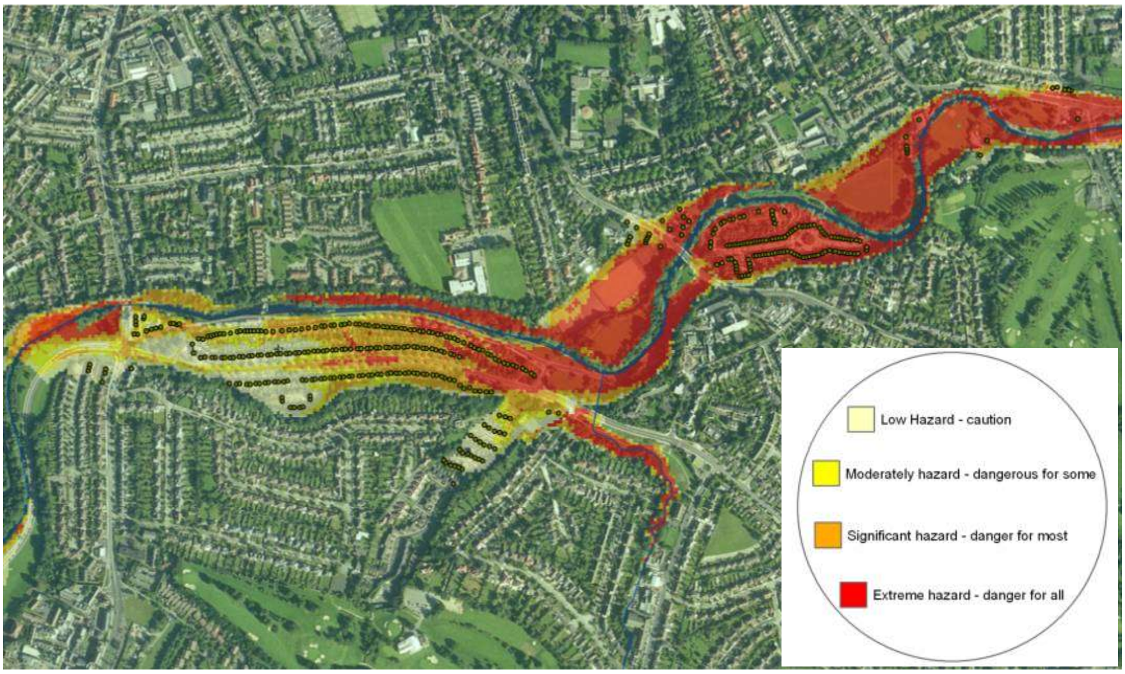


Figure 4-3 Example flood hazard mapping in the Dodder Catchment

A description of the flood hazard and mechanisms, is summarised for each sub-model area within the Dodder catchment, based on the present day 10%, 1% and 0.1% AEP event flood mapping prepared for the Dodder CFRAM Study.

Upper Dodder: The upper reaches of the River Dodder are predominantly rural and the river banks have been retained in their natural state. The main mechanism of flooding along this reach is water exiting the river channel through low points in the river banks. The water then fills the natural river valley floodplain and causes little or no flooding to property. Flooding overtops the riverbanks during the 1% and 0.1% AEP events.

Middle Dodder: The middle reaches of the Dodder, stretching from approximately Firhouse weir to Rathfarnham Road Bridge, flows through both parkland and urbanised areas. Flooding along this stretch of river can be attributed in the main to low river banks/overtopping of existing defences or insufficient channel/floodplain capacity. In addition there are two large weirs along this stretch which produce elevated upstream water levels, reducing freeboard through this area and resulting in some flooding in extreme events. Flooding overtops the riverbanks during the 1% and 0.1% AEP events, with the 10% AEP event causing flooding in the vicinity of Firhouse Weir.

Lower Dodder: The lower reaches of the River Dodder, stretching from Rathfarnham Road Bridge to the confluence with the River Liffey, flows through a highly urbanised area. As before, the mechanism for flooding along this stretch of river is mainly low river banks/overtopping of existing defences or insufficient channel/floodplain capacity. Throughout this stretch, there is urban development adjacent to the river channel, with few green floodplain areas remaining. As a result, there is a large amount of property damage during flood events. There are also a series of large weirs along this stretch of river which serve to artificially raise upstream water levels. These high water levels reduce the available freeboard and locally increase flood risk. In addition a number of bridges along this stretch appear to have insufficient conveyance capacity for extreme flood events. The undersized bridges cause water to back-up producing elevated water levels upstream. The tidal section of the River Dodder stretches from below the weir at Ballsbridge, to the confluence with the River Liffey, a length of approximately 2 km. This portion of the catchment is highly urbanised. Tidal flooding in the Lower Dodder can be attributed entirely to overtopping of existing defences.

Fluvial flooding overtops the riverbanks during the 10%, 1% and 0.1% AEP events with tidal flooding on the downstream reaches during the 0.5% and 0.1% AEP events..

Tallaght Stream: The Tallaght Stream tributary of the River Dodder flows through a highly urbanised suburb of Dublin City. However a significantly wide riparian strip has been maintained along the stream reducing potential property damage during flood events. Flooding along this stream can be attributed to a combination of insufficient channel capacity and insufficient bridge/culvert conveyance capacity. Flooding generally overtops the riverbanks during the 1% and 0.1% AEP events, with the 10% AEP event causing flooding in the vicinity of some bridge and weir structures.

Owendoher Stream: The Owendoher Stream tributary of the River Dodder flows through a highly urbanised section of the catchment. Flooding along this stream only occurs during extreme conditions (0.1% AEP) and can be attributed to low stream banks or insufficient channel/floodplain capacity. In addition, there is insufficient conveyance capacity at two bridge/culvert structures causing water to back-up producing elevated upstream water levels. There are also a number of weir structures along this stream which locally increase upstream water levels, reducing available freeboard and increasing flood risk. Flooding overtops the riverbanks during the 0.1% AEP event.

Whitechurch Stream: The Whitechurch Stream tributary of the Owendoher Stream flows through both parkland and urbanised areas. The stream is heavily modified with a large number of bridges/culverts and weirs. Flooding along this stretch of river can be attributed in the main to low stream banks/overtopping of existing defences or insufficient channel/floodplain capacity. In addition, there is insufficient conveyance capacity at a large number of bridge/culvert structures causing water to back-up producing elevated upstream water levels. There are also two large weir structures along the stream which locally increase upstream water levels, reducing available freeboard and increasing flood risk. Flooding overtops the riverbanks during the 10%, 1% and 0.1% AEP events.

Little Dargle Stream: The Little Dargle flows through both parkland and urbanised areas. A significant length of this stream is currently culverted and the remaining open channel sections have been provided with a wide riparian strip. For these reasons there is little flooding along this stretch of river. The flooding that does occur can be attributed to low stream banks/overtopping of existing defences or insufficient channel/floodplain capacity. In addition, there is insufficient conveyance capacity at a number of bridge/culvert structures causing water to back-up producing elevated upstream water levels. There are also a number of weir structures along this length of stream which locally increase upstream water levels, reducing available freeboard and increasing flood risk. Flooding overtops the riverbanks during the 10%, 1% and 0.1% AEP events.

Dundrum Slang: The Dundrum Slang flows through a highly urbanised area and is heavily modified with a large number of bridges/culverts, weirs and canalised sections. Flooding mechanisms along this stretch of river are mainly low stream banks/overtopping of existing defences or insufficient channel/floodplain capacity. In addition, there is insufficient conveyance capacity at a number of bridge/culvert structures causing water to back-up producing elevated upstream water levels. There are also a number of weir structures along this length of stream which locally increase upstream water levels, reducing available freeboard and increasing flood risk. Flooding overtops the riverbanks during the 1% and 0.1% AEP events, with 10% AEP causing flooding locally in the vicinity of weirs and bridges.

5 FLOOD RISK ASSESSMENT

Having mapped flood extent and hazard in the Dodder catchment, this chapter of the Plan describes the impacts of flooding; considered under three categories:

- Economic: loss or damage to buildings or infrastructure, and the disruption of activities that have economic value;
- Social: loss or damage to human life, health, community and social amenity; and
- Environmental and Heritage: consideration of the sensitivity of the river environment, habitats and species, plus the cultural and historical environment, to flooding.

The 1% AEP fluvial and 0.5% AEP tidal events represent the National design standard for the prevention of fluvial and tidal flooding, respectively. The economic, social, environmental and heritage flood risks for these design events were identified so that a direct comparison of the benefits of providing different flood risk management options could be made.

5.1 ECONOMIC FLOOD RISK

5.1.1 Risk to properties

Significant economic damages occur where floodwater gets above the threshold level of a building, for example, an entrance door. Under floor and basement flooding also cause economic damages. Economic damages can result from all sources of flooding, and can affect all areas within the flood extents for the Dodder catchment. The potential economic damage estimates in this Dodder Catchment FRMP, due to fluvial and tidal flooding, include damages to both residential and commercial properties (which includes community buildings).

The economic damages resulting from a range of AEP floods (50%, 20%, 10%, 4%, 2% and 1% AEP) were estimated across the Dodder catchment. This was done by estimating long-term (over 50 years) average economic impacts to properties. The damage figures are based on published property damage figures available in the Flood Hazard Research Centre's Multi Coloured Manual and converted to euro values using the current Purchasing Power Parity (PPP) rate.

This assessment is used to determine the economic viability of flood risk management options, whereby the economic benefit that a flood risk management option provides is compared to the costs of the option to form a benefit-cost ratio.

Table 5-1 details the property numbers affected by fluvial/tidal flood risk in the Dodder catchment for the 1% AEP fluvial and 0.5% AEP tidal events. Some locations on the lower Dodder are affected by both fluvial and tidal flood risk; therefore assessment of combined economic damages has been undertaken by assuming the higher damages for a given property, from either fluvial or tidal risk. This is a conservative approach, but appropriate at this level of analysis.

Table 5-1 also shows, for the range of flood event probabilities, Annual Average Damages (AADs) which is an indication of the average damage costs per year that occur as a result of flooding. The average annual damage is worked out from the damages caused by different sized flood events, weighted by their probability of occurrence (calculated over a period of 50 years).

The assessment of the viability of flood risk management options focuses on areas where a number of homes and other properties are prone to flooding within the 1% AEP fluvial flood event and 0.5% AEP tidal event and hence where significant economic (and social) risk exists. A number of upstream areas were identified where there are no economic damages for the 1% AEP fluvial event and 0.5% AEP tidal event; these are portions of the upper/middle Dodder, Dodder, Tallaght Stream and Owendoher. For the purposes of the flood risk analysis some sub-model areas were further subdivided to allow flood risk management options for ten localised areas of potential significant risk (APSRs)/flood cells to be investigated in greater detail. These localised areas are shown in Figure 5-1.

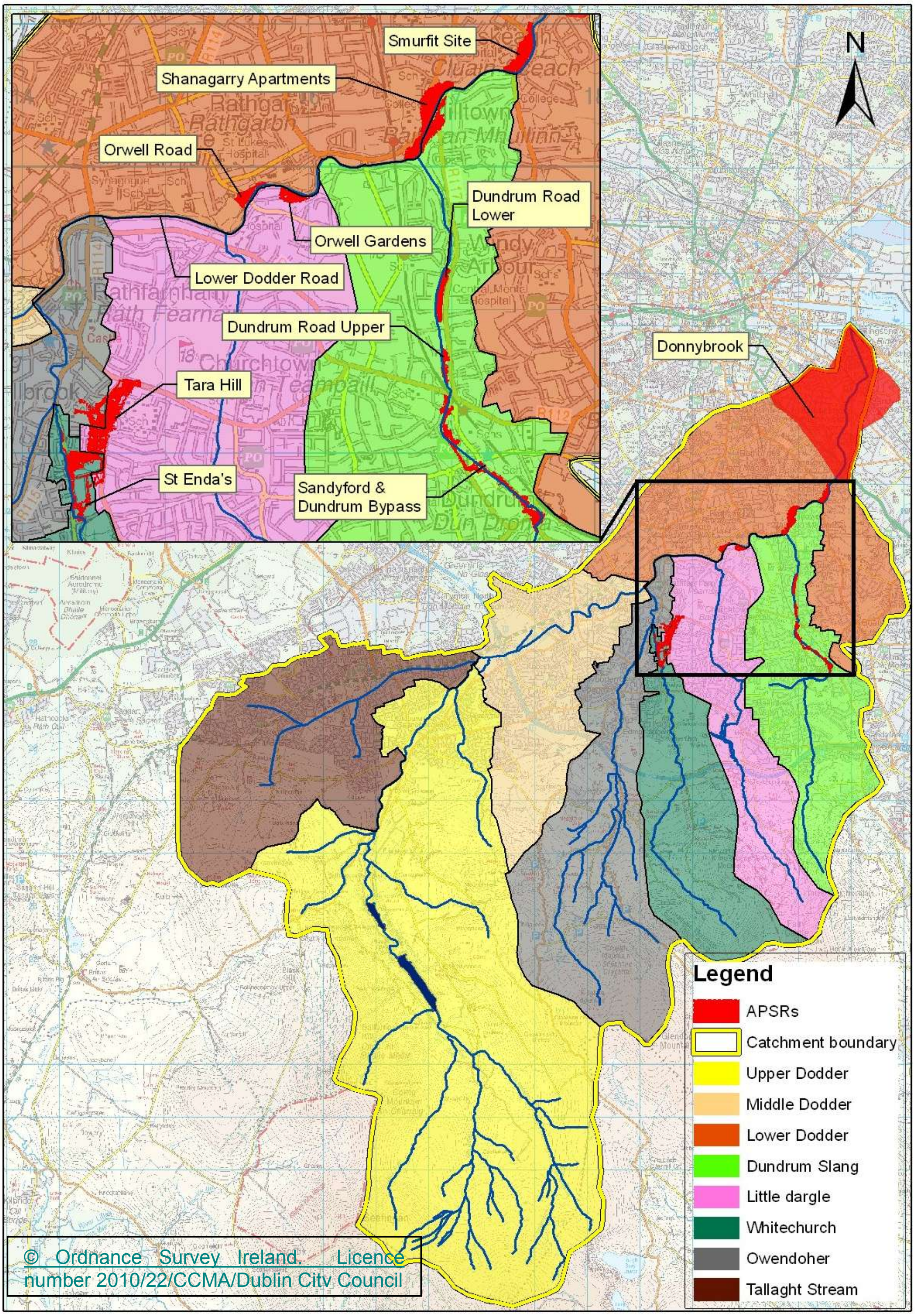


Figure 5-1 Areas of Potential Significant Risk (APRSs)/flood cells in the Dodder Catchment

Table 5-1 Damages for properties at risk in the Dodder catchment

Area	Number of Properties damaged during a 1% AEP event	50% AEP Damage (€)	20% AEP Damage (€)	10% AEP Damage (€)	4% AEP Damage (€)	2% AEP Damage(€)	1% AEP Damage (€)
Dodder catchment	1466	0	0	14,258	1,435,909	19,700,056	82,395,482
Dodder upper, middle & lower	1283	0	0	2,508	44,719	17,237,367	76,798,154
Tallaght stream & tributary	0	0	0	0	0	0	0
Owendoher & Whitechurch streams	133	0	0	0	1,356,595	1,797,647	2,208,448
Little Dargle	2	0	0	0	0	0	677,553
Dundrum Slang	48	0	0	11,750	34,595	665,042	2,711,327
Orwell Gardens	96	0	0	0	0	1,140,755	8,043,125
Shanagarry Apartments	68	0	0	0	4,576	7,634,293	8,780,844
Smurfit Site	32	0	0	0	0	347,280	508,936
Orwell Road	5	0	0	0	0	195,267	300,762
St Enda's residential	123	0	0	0	1,277,870	1,713,277	1,976,268
Tara Hill residential	8	0	0	0	1,973	7,618	155,428
Dundrum & Sandyford Bypass	31	0	0	0	0	13,811	1,839,530
Dundrum Road Upper	5	0	0	0	24,433	71,944	81,536
Dundrum Road Lower	12	0	0	0	10,162	579,287	790,261
Donnybrook	1177	0	0	0	0	8,785,536	61,987,965

As expected, the greatest economic property damages occur in the lower Dodder area, which has the highest density of properties and a significant flood risk due to both fluvial and tidal flooding. The Whitechurch Stream and Dundrum Slang are at moderate economic flood risk and the majority of the remaining urban areas have a lower economic risk of flooding.

5.1.2 Risk to infrastructure

Both nationally and regionally available infrastructure datasets have been used to determine the length, area or number of infrastructure assets that are located within flood risk areas. The infrastructure assets include transport routes (for example road and rail) and utility assets (for example power substations). The depth of flooding and flood hazard affect the degree of disruption and damage to infrastructure assets and these factors have also been taken into account when assessing the flood risk.

Table 5-2 indicates the length of transport routes and number of utility assets that are at risk in the Dodder catchment.

Table 5-2 Level of flood risk to infrastructure assets

Area	Length of Infrastructure (km)	No of Utility Assets
Dodder catchment	21.9	2
Dodder upper, middle & lower	16.1	2
Tallaght stream & tributary	0.3	-
Owendoher & Whitechurch streams	3.0	-
Little Dargle	0.3	-
Dundrum Slang	2.2	-
Orwell Gardens	0.3	-
Shanagarry Apartments	1.1	-
Smurfit Site	0.3	-
Orwell Road	0.1	-
St Enda’s residential	2.1	-
Tara Hill residential	0.8	-
Dundrum & Sandyford Bypass	1.2	-
Dundrum Road Upper	0.03	-
Dundrum Road Lower	0.04	-
Donnybrook	13.5	1

5.2 SOCIAL FLOOD RISK

The social risk of flooding has been measured through the number of residential and commercial properties (including community buildings) and social amenity sites located within the flood extent. Not all properties located within the flood extent will suffer economic damages, such that only driveways and gardens will be flooded in some cases, but this flood hazard will result in a degree of social vulnerability. The “An Post GeoDirectory” was used to assess the number and type of properties located within the fluvial and tidal flood extents for a range of probability events. The depth of flooding and flood hazard affect the degree of disruption to people and these factors have also been taken into account when assessing the flood risk.

Table 5-3 indicates the number of residential and commercial properties (which includes both community buildings and social amenity sites such as sports clubs, public parks, etc) at risk from flooding. The most significant number of properties at social risk is again located in lower Dodder (Donnybrook area) which is at risk from fluvial and tidal flooding.

Table 5-3 Level of social flood risk

Area	Number of Properties within the extent of the 1% AEP event	Number of Residential Properties	Number of Commercial Properties	Number of Social Amenity Sites
Dodder catchment	1875	1723	152	13
Dodder upper, middle & lower	1634	1517	117	10
Tallaght stream & tributary	0	0	0	0
Owendoher & Whitechurch streams	173	154	19	2
Little Dargle	2	2	0	1
Dundrum Slang	66	52	14	0
Orwell Gardens	96	96	0	0
Shanagarry Apartments	68	65	3	0
Smurfit Site	32	25	7	0
Orwell Road	5	5	0	0
St Enda's residential	148	134	14	0
Tara Hill residential	17	15	2	0
Dundrum & Sandyford Bypass	36	30	6	0
Dundrum Road Upper	12	6	6	0
Dundrum Road Lower	13	11	2	0
Donnybrook	1467	1362	105	0

5.3 ENVIRONMENTAL AND HERITAGE FLOOD RISK

Flooding is a natural process within the Dodder Catchment. Whilst some of the environmental features within the catchment, such as wetland habitats and the species they support, depend on periodic inundation; river and tidal flooding can also have a detrimental impact on the environment of the catchment, especially when the flooding is of high magnitude.

The environmental features located within both fluvial and tidal flood extents mapped for the Dodder Catchment have been identified and their sensitivity to changes in the existing flooding regime considered. This has enabled those features that could be positively or negatively affected by both predicted future changes in the flooding regime and/or the implementation of flood risk management options recommended in the Dodder Catchment FRMP to be identified and assessed.

Many of these environmental features require the maintenance of specific environmental conditions, including the management of flows, water levels and channel conditions, in order to meet both national and international legal requirements. These have been taken into account throughout the development of the Dodder Catchment FRMP through the SEA process.

The environmental features considered relevant to the Dodder Catchment FRMP include:

- The **water environment itself**, particularly with reference to the requirements of the WFD, including:

    - The quality (ecological and chemical) and quantity of water essential to provide drinking water, habitat for flora and fauna and support fisheries; and the risk of pollution from potential sources such as waste water treatment plants and landfills;

    - The physical condition of the river channels and estuaries including their morphology and physical processes, which are essential to provide suitable habitat for flora and fauna, including fisheries.

- The **natural environment**, including species of flora and fauna and their supporting habitats within the mapped flood extents of the Dodder Catchment, as well as adjacent to the catchment and downstream, that are reliant on the maintenance of specific environmental conditions.

    - Some aquatic and wetland habitats, and associated species, rely on periodic flooding, although frequent flooding followed by periods of dry conditions is unlikely to be beneficial to habitats and species that require prolonged wet conditions. Other habitats and associated species are highly sensitive to flooding which can cause adverse changes in species composition as a result of changes to drainage conditions, increased nutrient availability, reduced oxygen in the soil, erosion and increased mobility of toxic metals.

    - The catchment contains several designated sites of international nature conservation importance; and two key areas, namely: Glenasmole Valley SAC (Special Area of Conservation) and Wicklow Mountains SAC and SPA (Special Protection Area), are designated Natura 2000 sites which directly intersect the catchment. The Dodder Catchment also contains several designated sites of national nature conservation importance (proposed Natural Heritage Areas) and a wider biodiversity of aquatic and wetland species of flora and fauna.

- The **built environment**, including sites and structures protected for their **cultural heritage** value for which flooding has the potential to cause physical damage such as the erosion of and damage to archaeological earthworks, buried sites and standing buildings/structures as a result of repeated floodwater inundation. Flooding can also cause damage to the integrity of protected structures, their construction materials, interior and exterior decoration and significant interior features. The catchment contains approximately 30 sites and structures, including bridges, buildings (including churches and houses), graveyards, holy sites and water-powered mills, within the mapped flood extents, as well as Architectural Conservation Areas (ACAs) and areas of archaeological potential.

- The **use and value** of the water environment and the surrounding land for recreation and tourism, including riverside access for angling, water-based sports and amenities located within the mapped flood extents.

- The **surrounding land use and landscape** of the catchment; which includes areas of high quality agricultural land and landscapes designated for their scenic value within the mapped flood extents.

5.4 EXISTING FLOOD RISK MANAGEMENT

A number of existing flood risk management measures currently exist in the Dodder Catchment which provide a degree of control and management of flood risk to both urban and rural areas. These management measures include:

- existing defence structures;
- operation of the lower Bohernabreena reservoir;
- raised property floor levels and limited development (in some areas);
- Sustainable Drainage Systems (SuDS);
- flood defence asset surveys; and
- coastal flood forecasting and monitoring system.

Existing defence structures: The majority of existing structural defences are located on the Lower Dodder and Dodder Estuary. Flood walls and embankments along both banks of the River Dodder offer a degree of flood protection to properties and other assets on the floodplain; however the effectiveness of these defences is reduced through inconsistencies in defence heights, poor physical condition of the defences and gaps in the defences.

In some cases, existing infrastructure assets, such as riparian boundary walls, also provide a degree of flood protection. As these infrastructure assets were not constructed as formal flood defences, their flood protection potential is limited.

Operation of the lower Bohernabreena reservoir: As described in Section 3.0, the Lower Bohernabreena Reservoir can be drawn down to provide additional water storage preceding an expected storm event in order to reduce peak flows and flooding in the downstream catchment.

Raised property floor levels and limited development: To reduce the level of flood risk to new developments, the Greater Dublin Strategic Drainage Study (2005) recommended that the finished floor level in new developments which are located close to watercourses must be a minimum of 500 mm above the highest recorded flood level, or the boundary of the 1 in 100 year flood event, whichever is the higher.

Sustainable Drainage Systems (SuDS): To limit the surface water runoff after construction to pre-construction “Greenfield” levels, Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council adopt the best practice guidance on the design of SuDS contained in the Greater Dublin Strategic Drainage Study (2005). SuDS is mandatory for all new developments, except where the developer can demonstrate that its inclusion is impractical due to site circumstances, for example, on sloping grounds. Where SuDS cannot be provided, the developer must provide alternative means of dealing with runoff and pollutants. The assumption must be that SuDS will be used, with the onus of responsibility with the developer to provide SuDS measures to the planning authority’s satisfaction, or to demonstrate that SuDS cannot be provided or is not applicable.

Flood defence asset surveys: A flood defence asset survey has been undertaken as part of this CFRAM Study. This provides the authorities with data on the standard of the existing defences allowing the planning of ongoing maintenance and inspection regimes for the defence system. Information on type, location and condition of all defence assets is provided in the Defence Asset Database created as part of this project. Figure 5-2 shows the location highlights the areas of Dodder catchments which benefit from defences.

Figure 5-2 Location of the surveyed defences and defended areas

Coastal flood forecasting and monitoring system: Dublin City Council, the Marine Institute, Met Éireann and consultants developed a tidal forecasting system under the SAFER Project partnership in response to coastal flooding in 2002. The system provides valuable information and to the drainage and fire departments and other responder agencies. DUBCAST incorporates two elements:

- Tidewatch - manual computation to forecast surge 4 days ahead of an event based on a formula developed by O'Connell & Co; and

- Triton - a computational forecast giving 36 hours warning at 64 coastal locations.

6 FLOOD RISK MANAGEMENT OPTIONS

This chapter of the Plan summarises the process used to establish flood management objectives, to screen measures and to develop and evaluate flood management options for the areas at risk of flooding within the Dodder catchment.

6.1 INTRODUCTION

An option development process, illustrated in Figure 6-1, has been used to ensure that the assessment of flood risk management options for the Dodder CFRAM Study is evidence-based, transparent and inclusive of stakeholder and public views. The methodology is an agreed approach developed by the OPW for the National CFRAM programme.

Flood extent maps identify locations within the Dodder Catchment at risk from economic, social and environmental and heritage flood impacts. The option assessment process considers technical and other aspects associated with each option in addition to flood impacts. Where the risks are significant, the study has identified a range of potential options to manage these risks.

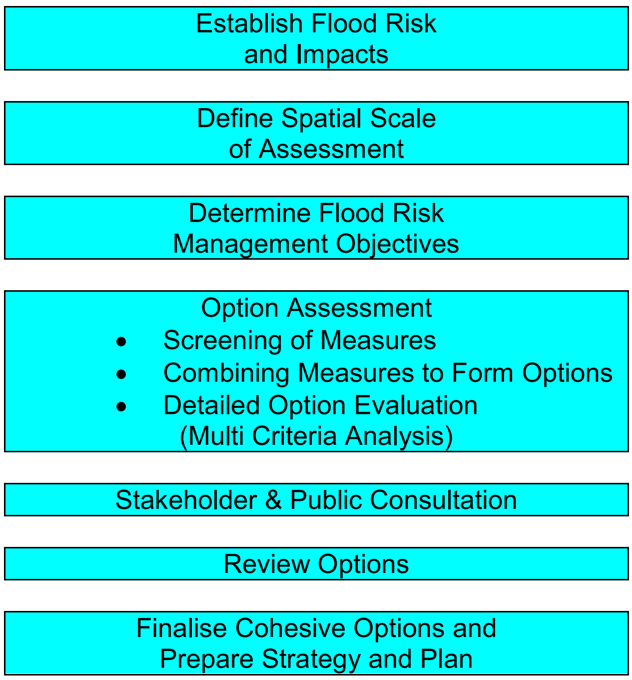


Figure 6-1 Summary of the option development process

To structure the process for option development, the Dodder catchment was divided into a number of assessment units, which are defined at four spatial scales:

- **Catchment scale**: in this case the Dodder catchment study area (~120 km^2);
- **Sub catchment or analysis unit (AU) scale**: these are main sub-catchments individually or grouped in cases where flood extents interact (e.g. the Dodder (upper, middle and lower) or five main tributaries);

- **Areas of potential significant risk (APSR) or flood cell scale**: these are existing urban areas with high degrees of flood risk and in some cases localised areas (flood cells) that may have stand-alone flood risk management options;

- **Individual risk receptor (IRR)**: an individual asset of particular economic or social value that has been identified as being prone to flooding and hence represents a significant risk in its own right, such as transport and utilities infrastructure, which may require specific consideration during the development of the flood risk management options.

The catchment, sub catchments/AUs, APSRs and flood cells in the Dodder catchment identified for the option assessment process are listed in Table 6-1 (as shown on Figure 5-1).

Table 6-1 Catchment, sub catchment/AUs, APSRs and flood cells for the Dodder catchment

Catchment	Sub catchment /Assessment Units	APSRs & Flood Cells
Dodder catchment	Dodder (upper, middle & lower)	Orwell Gardens Orwell Road Shanagarry Apartments Smurfit Site Donnybrook
	Tallaght stream & tributary	
	Owendoher & Whitechurch streams	Tara Hill residential St Enda's residential
	Little Dargle	
	Dundrum Slang	Dundrum Road Upper Dundrum Road Lower Dundrum & Sandyford Bypass

Table 6-2 lists the Individual Risk Receptors (IRRs) within the catchment, based on the criteria that they are at risk from greater than 100 mm flood depth from a 1% AEP fluvial event or 0.5% AEP tidal event; these are also shown in Figures 6-2 to 6-4.

Table 6-2 Individual risk receptors

Individual Risk Receptor	Importance
AIB Centre Ballsbridge (off Merrion Road and Serpentine Road)	National Importance
AVIVA Rugby & Soccer Stadium	National Importance during certain fixtures and Concerts
Royal Dublin Society (RDS)	National Importance during Show jumping and some other events. Concerts and football matches also staged there
Shelbourne Park Dog Track	Regional Interest (Protected by current defence works)
Marian College School	Local Receptor. Parking and facilities are occasionally for AVIVA stadium.
American, Israeli and Czech Republic Embassy's on Northumberland Road.	Local Receptor
Church of Ireland, Anglesea Road.	Local Receptor
Dublin Bus, Beaver Row, Donnybrook.	Local/South City Receptor

Individual Risk Receptor	Importance
Dart Line at Lansdowne Road Bridge and Serpentine Avenue crossing.	Local and Regional Receptor
Merrion Cricket Pitch Occasionally used as parking for events in RDS.	Local Receptor
Leinster and Old Wesley Rugby football ground, Donnybrook.	Local/Regional and very occasionally national receptor
Major Roadways disrupted. Shelbourne Road, Merrion Road, Northumberland Road, Donnybrook Road (N11), Stillorgan Road (N11), Clonskeagh Road.	Local/Regional/National Receptors
Dundrum Shopping Centre & Theatre	Local Receptor on Dundrum Slang.
ESB sub-station, Dodder Road Lower,	Local Receptor - feeds Mount Carmel Hospital and local grid for a distance of up to 4km around it.
N81, Tallaght Bypass,	Regional Receptor - can be flooded from Tallaght Stream during the 1000 year event.

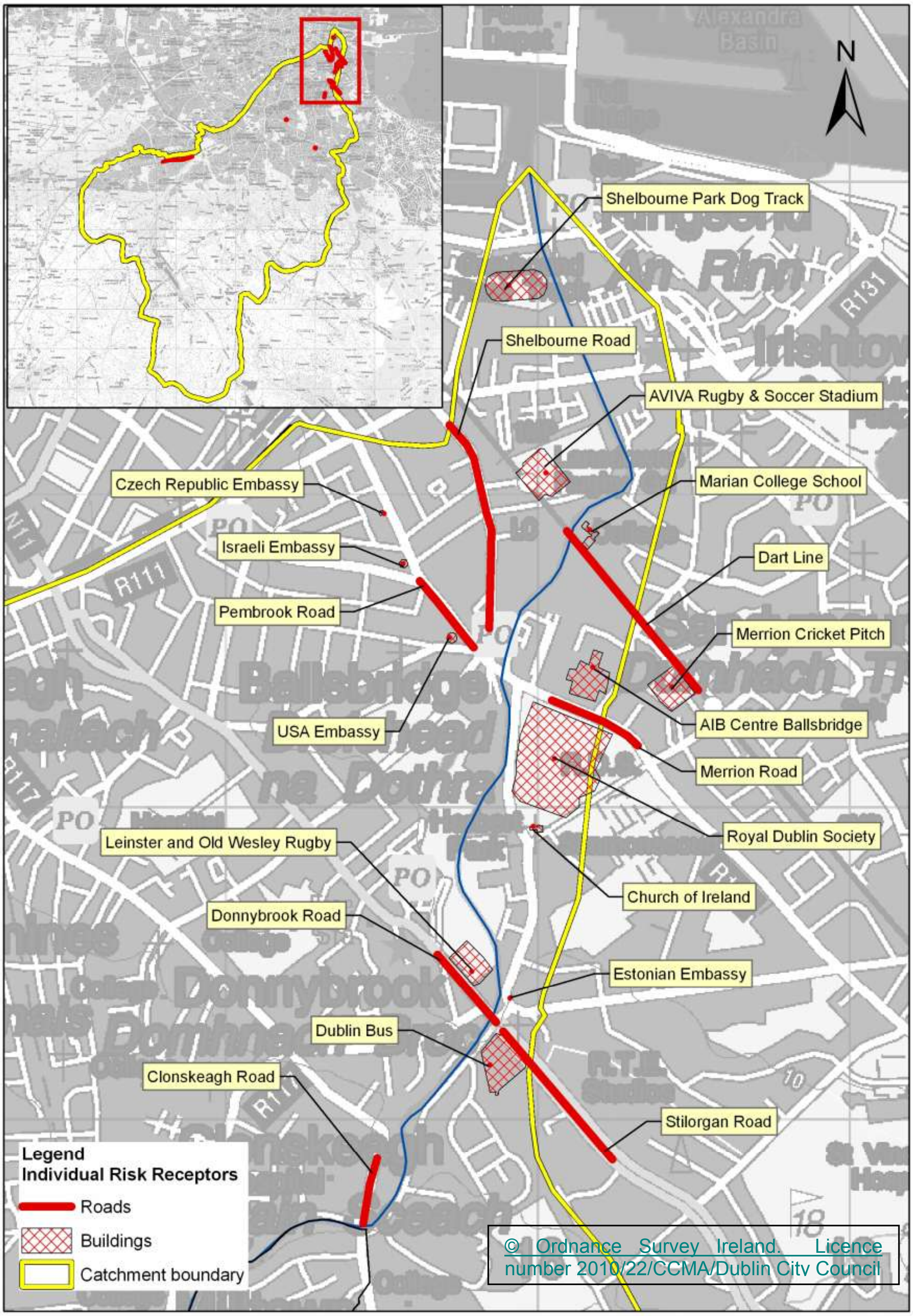


Figure 6-2 Individual risk receptors in the Dodder Catchment

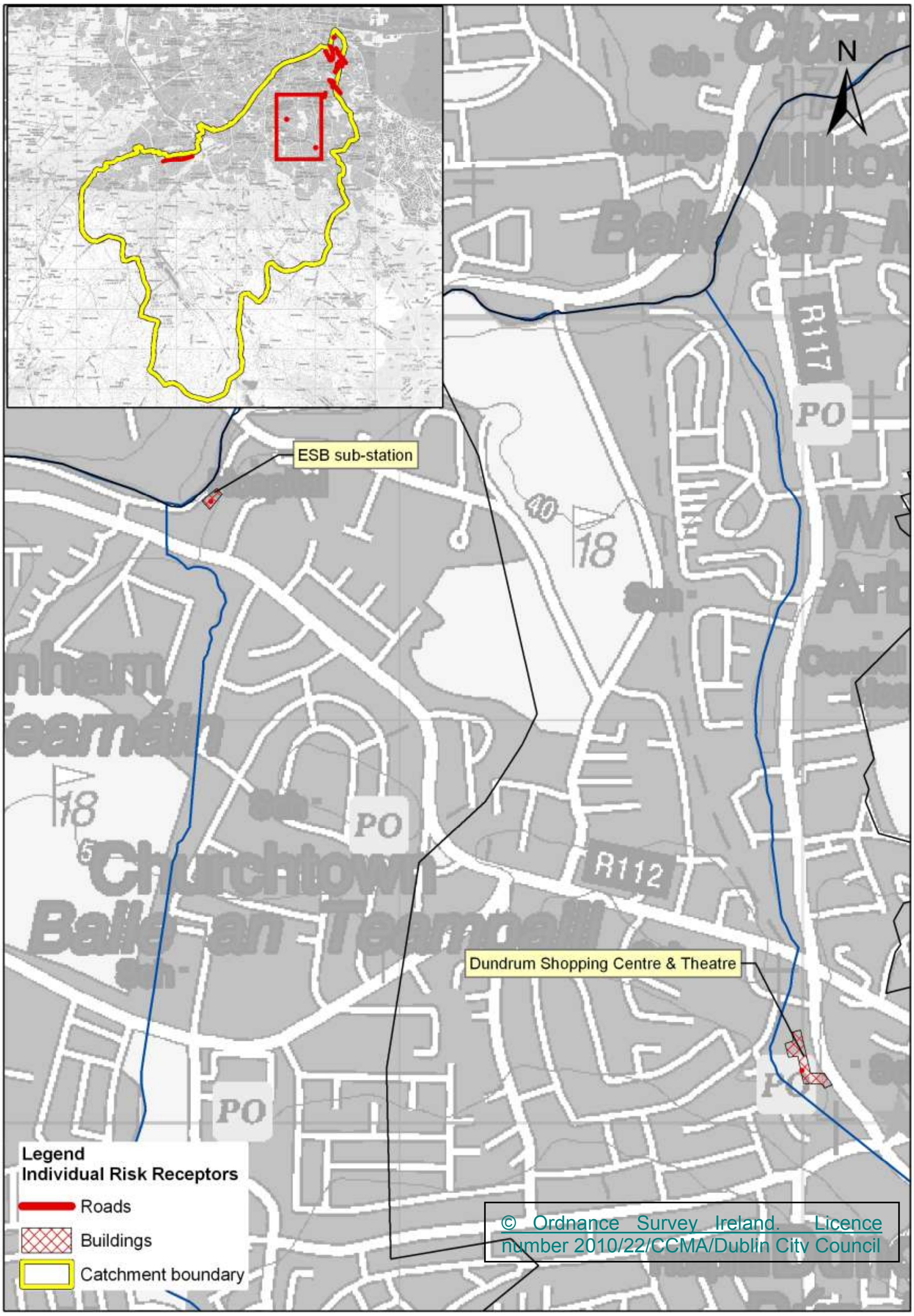


Figure 6-3 Individual risk receptors in the Dodder Catchment

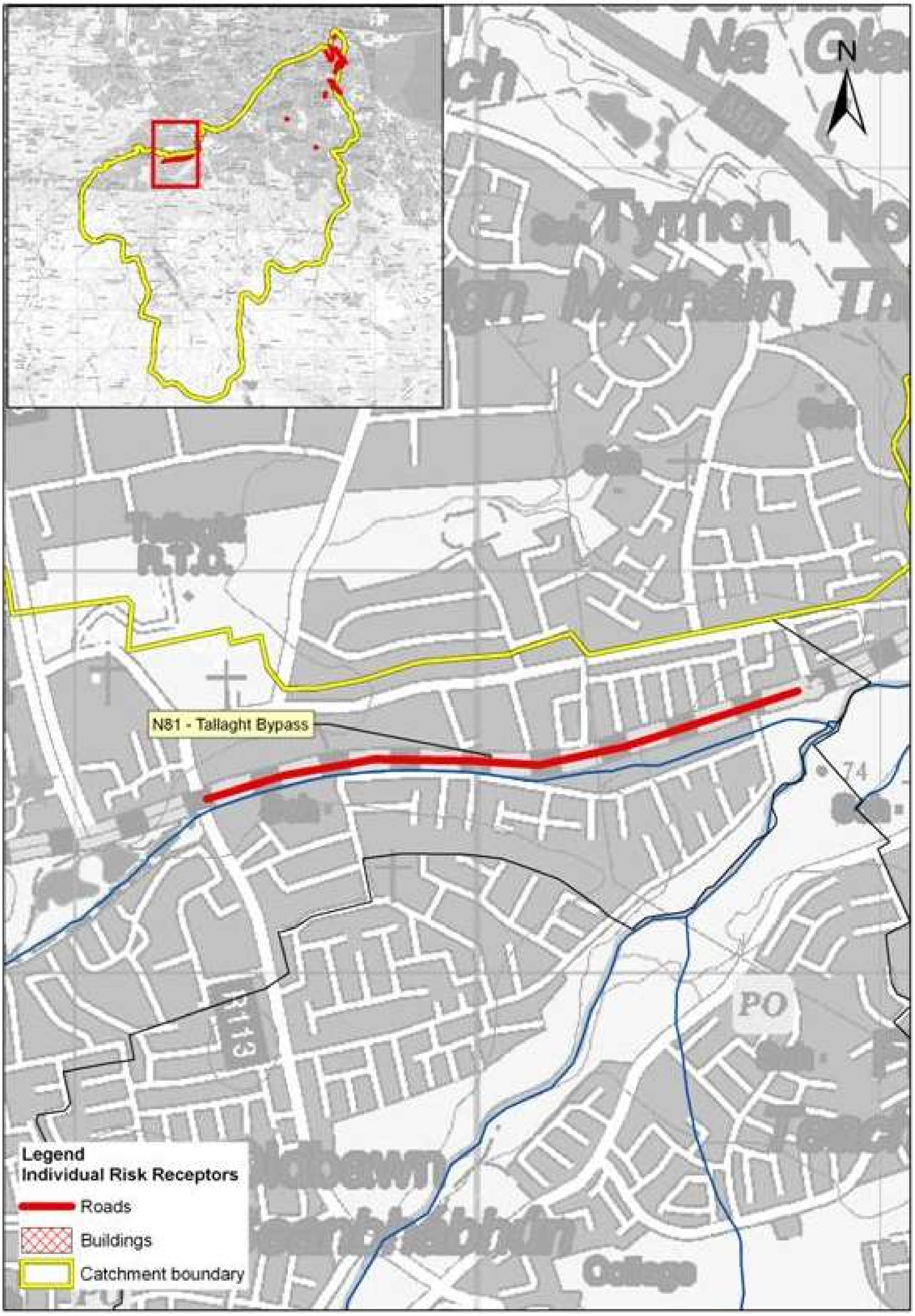


Figure 6-4 Individual risk receptors in the Dodder Catchment

6.2 FLOOD RISK MANAGEMENT OBJECTIVES

The use of catchment-specific flood risk management objectives is integral to the option assessment process. The objectives were identified at National level at the outset of the process, giving consideration to the requirements of the Floods Directive, and refined through stakeholder consultation. A total of 15 objectives were applied to the Dodder Catchment under four different categories:

- **Economic**. One objective covering economic return on investment, risk to infrastructure and risk to agricultural land, value 30%:

- **Social**. Four objectives covering risk to human health and life, community and social amenity, value 30%:

- **Environmental & Heritage**. Six objectives covering the requirements of the Water Framework Directive (WFD), pollution, flora and fauna, fisheries, landscape character and cultural heritage, value 30%. These objectives were addressed via the SEA and HDA processes: and

- **Technical & Other**. Four objectives covering operation, health and safety and sustainability of FRM options, value 10%.

The use of these objectives (Table 6-3) as part of the multi-criteria analysis was intended to ensure that the flood risk management options address risks to people, property, the environment and cultural heritage taking into account related constraints and opportunities. The full list of objectives used as part of the option development process of the Dodder CFRAM Study can be found in Appendix B.

Table 6-3 Flood risk management objectives

Core Criteria	Objective	
Economic	a	Ensure flood risk management expenditure is risk based
Social	a	Minimise risk to human health and life
	b	Protect key infrastructure
	c	Protect existing, and where possible create new waterside access and recreational facilities
Environmental & Heritage	a	Safeguard and promote sustainable land use in keeping with WFD
	b	Support the achievement of good ecological status/potential (GES/GEP) under the WFD. Particularly morphology as a supporting element to ecological status
	c	Protect the flora and fauna of the catchment and, where possible, enhance biodiversity
	d	Protect, and where possible enhance, fisheries within the catchment
	e	Protect, and where possible enhance, landscape character and visual amenity
	f	Protect and where possible enhance features of cultural heritage importance and value, including their settings
	g	Protect soil function
Technical	a	Ensure flood risk management options are operationally viable and to minimise maintenance required.
	b	Ensure flood risk management options are technically and logistically

Core Criteria	Objective	
		viable
	c	Ensure flood risk managed effectively into the future
Other	a	No increase in flood risk to other areas

6.3 OPTION ASSESSMENT PROCESS

Flood risk management options were developed for analysis units (AUs), APSRs and flood cells, through a three stage process, based around fulfilling the identified flood risk management objectives.

6.3.1 Screening of measures

The first step of the option assessment process was the identification of a long list of potential flood risk management measures, both structural and non-structural. These measures are listed in Table 6-4.

Table 6-4 Long list of measures

Long-list of Measures
Do Nothing
Flood Warning System
Catchment Wide SuDS Implementation
Reactive Maintenance Regime
Proactive Maintenance Regime
Public Awareness Campaign
Rehabilitation of Existing Defences
Upstream Storage
Tidal Barrage
Improvement of Channel Conveyance
Relocation of Properties
Hard Defences (for example walls and embankments)
Culverting
Diversion of Watercourses
Overland Floodways
Deculverting/replacing bridges
Individual Property Protection or Flood Proofing

The long-list of potential measures was considered for the catchment as a whole, AU, APSR /flood cell (see Table 6-1). These measures were initially assessed against two criteria, namely whether the measure was applicable and practical given the nature and type of flooding experienced in the Dodder Catchment. A “no” answer eliminated the measure from being considered further.

After the initial screening process the following measures that were deemed either not applicable or suitable to the Dodder catchment. These were:

- Relocation of Properties – this was deemed impracticable given the number and type of properties involved;

- Fluvial Food Warning System – fluvial warning was considered to be non-applicable for the Dodder at catchment scale at the current time pending a national study into flood forecasting and warning systems. This is due to the rapid response time of the catchment’s rivers which results in insufficient time for an effective flood response to be mounted. The OPW has begun the process of undertaking a strategic review of options for flood forecasting and warning (FFW) in Ireland which will look at the possibility of using rainfall radar forecasting techniques which could provide additional response time to Local Authorities and the Emergency Services. Further consideration will be given to this an option for the Dodder catchment on completion of this strategic review. Dublin has however already developed a number of elements for forecasting. These range from a full system for tidal flood forecasting and monitoring which is already in place to partial systems for fluvial (several river gauges) and pluvial (an increasing number of linked rain gauges); and

- Culverting- this was considered impractical given the major watercourses involved in the catchment.

All remaining measures were assessed on their economic feasibility, and their social, environmental and cultural impact. Any measures considered as being potentially beneficial to either the catchment, AU, APSR /flood cell were taken forward to be assessed further.

Each spatial scale of analysis therefore has a range of screened measures that were taken forward to be developed into a potential flood risk management options.

6.3.2 Combining measures to form options

The range of measures that were deemed as potentially beneficial were developed into a series of options which aimed to alleviate the flooding experienced from a 1% AEP fluvial and/or 0.5% AEP tidal event in each of the various spatial scales of assessment.

A total of 45 potential flood alleviation options were developed and carried forward for further assessment.

The options carried forward for all spatial scales of analysis are summarised in Appendix D.

6.3.3 Detailed option evaluation

Each of the 45 potential flood management options were then subject to a detailed multi-criteria analysis (MCA) against three main criteria, (economic viability, social, environmental and heritage impacts). Consideration was also given to technical and other criteria (accounting for the technical difficulty in implementing or constructing each option and whether the proposed option had the potential to cause flood risk elsewhere). An example table is provided in Appendix B.

Each of the main criteria were given an equal weighting while the further criteria were given a lesser weighting. Where appropriate, the main criteria were broken down into a range of sub-criteria. All criteria/sub-criteria were then scored against a defined set of objectives to determine whether they could be considered has having a beneficial or negative impact on each respective assessment unit. It was acknowledged that each sub-criteria had varying levels of local or international importance and the scoring for each of them was weighed to reflect this. Appendix C shows the weighting and scoring scales for both the criteria and sub-criteria.

The scoring system was developed so that any option with an overall score greater than zero would be considered as being more beneficial than the current scenario and was taken forward as a preferred option. Conversely any option with a negative score was considered as being worse than the current scenario and was therefore eliminated from the process.

The MCA tables incorporating all scoring and objectives are provided in Appendix D. Table 6-5 summarises the preferred options following the MCA process.

Table 6-5 Preferred Options

Area of Assessment	Preferred Option
Catchment wide	Support measures - SuDS, asset surveys, maintenance, early coastal warning and public awareness along with monitoring and policy measures
Little Dargle	Hard Defences
Lower Dodder - Donnybrook	Hard Defences
Orwell Gardens	Hard Defences
Shanagarry Apartments & Smurfit Site	Hard Defences
St Endas & Tara Hill	Hard Defences, Dredging and Removal of Weirs

It should be noted that a factor in the technical assessment of all potential options was the sustainability and adaptability of the option to future flood risk and climate change. An objective was therefore considered under the technical criteria which assessed the ability of each of the proposed options to be adapted to at a later date as more about the effects of climate change are established. This is reflected in the technical objective where an option is assessed against its adaptability to account for flood risk from middle range and high end future flood scenarios.

It should also be noted that there are a number of catchment wide measures which, whilst not effective on their own, provide a very valuable degree of flood protection to the catchment supporting other measures at more localised scales. These include existing measures such as SuDS policy implementation, coastal flood forecasting, maintenance of defences and operation of reservoirs. New catchment wide and non-structural measures that are also required include preparation of flood management plans, education and awareness programmes and hydrometric programmes. These measures have been grouped and assessed at catchment wide scale in support of other options.

6.4 PRODUCTION OF COHESIVE OPTIONS

The options listed in Table 6-5, along with feedback from public consultation and stakeholder involvement, point the way towards the major components of the Dodder Catchment FRMP, but they require further consultation, review and further consideration to produce a completely sustainable and comprehensive catchment flood risk management plan.

As part of the MCA a range of secondary criteria were also considered which were produced with a view to addressing the “3P” approach (Prevention, Preparedness and Protection) advocated in the Floods Directive.

The **Protection** measures are essentially summarised in Table 6-5.

Prevention: The publishing of The Planning System and Flood Risk Management Guidelines by the Department for the Environment, Heritage and Local Government in conjunction with the OPW in November 2009 aim to prevent development in those areas at high risk. The flood risk and hazard maps produced as part of this plan will form an evidence base for implementation of the Planning System and Flood Risk Management Guidelines.

Preparedness: Preparedness is a proven method of reducing the flood risk to existing properties and infrastructure. A range of preparedness measures were considered as secondary measures as part of the MCA process which included:

- Reactive Maintenance
- Proactive Maintenance
- Flood Forecasting
- Public Awareness
- Flood Warning.

While none of these measures would be adequate on their own to alleviate the risk of flooding they can minimise the damage to property and risk to life should an extreme event occur. A report has been prepared as part of this project which provides the basis around which future maintenance regimes could be adopted by each of the Local Authorities with a view to minimising the risk.

6.5 INDIVIDUAL RISK RECEPTORS

An individual risk receptor (IRR) is an individual asset of particular economic or social value that has been identified as being prone to flooding and hence represents a significant risk in its own right, such as transport and utilities infrastructure, which may require specific consideration during the development of the flood risk management options.

The majority of Individual Risk Receptors as defined in Table 6.2 will be protected by the hard defences currently being proposed in the APSR Dodder Lower downstream of Donnybrook. Those outside these areas include:

- ESB sub station on Dodder Road Lower affected by the Dodder;
- N81 By-Pass affected by the Tallaght Stream;
- Dundrum Shopping Centre and Theatre affected by the Dundrum Slang Stream.

Each of these IRRs were included as part of the MCA process but none of the options considered received a positive overall scoring and therefore could not be considered as preferred structural options. However the findings of the assessment will be discussed with the owners and operators of the risk receptors with a view to improving awareness and response for these premises.

7 ENVIRONMENTAL ASSESSMENT

The Dodder Catchment FRMP is subject to Strategic Environmental Assessment (SEA) and Habitats Directive Assessment (HDA) to meet the requirements of the Irish Regulations transposing the EU SEA and Habitats Directives respectively.

This final Dodder Catchment FRMP is accompanied by an SEA Statement which provides information on the decision-making process and documents how environmental considerations, the views of consultees, and the recommendations of the SEA Environmental Report and Natura Impact Statement have been taken into account by, and have influenced, the Dodder Catchment FRMP.

7.1 BACKGROUND

SEA is required under EU Council Directive 2001/42/EC on the Assessment of the Effects of Certain Plans and Programmes on the Environment (the SEA Directive) and transposing Irish Regulations (the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 (SI No. 435 of 2004)) as amended by SI 200 of 2011 (hereafter referred to as simply the SEA Regulations); and the Planning and Development (Strategic Environmental Assessment) Regulations 2004 (SI 436 of 2004), as amended by SI 201 of 2011. Its purpose is to enable plan-making authorities to incorporate environmental considerations into decision-making at an early stage and in an integrated way throughout the plan-making process.

The overall aim of the SEA Directive is to '*provide a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development*.'

To achieve this, environmental constraints and opportunities relating to flood risk management within the Dodder Catchment have been considered throughout the development of the Dodder Catchment FRMP. This integrated approach has sought to ensure that environmental considerations are embedded within decision-making and that the environmental impacts of the recommendations of the Dodder Catchment FRMP are minimised, in line with national and international best practice guidance.

Specific consideration of the impacts of the Dodder Catchment FRMP on protected sites of European nature conservation importance (Natura 2000 sites) within the Dodder Catchment, as required under Council Directive (92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora (the Habitats Directive) and the transposing Irish Regulations (SI 94 of 1997), has also been undertaken. The main aim of the Habitats Directive is "*to contribute towards ensuring biodiversity through the conservation of natural habitats of wild fauna and flora in the European territory of the Member States to which the treaty applies*". The results of this assessment (referred to as an 'appropriate assessment') are outlined in a Natura Impact Statement (NIS) and are also integrated within the SEA process

The SEA and HDA processes also provided a framework for consultation with stakeholders and the general public throughout the development of the Dodder Catchment FRMP, as described in Section 2.0.

7.2 STRATEGIC ENVIRONMENTAL ASSESSMENT PROCESS

SEA is a process for evaluating, at the earliest appropriate stage, the environmental effects of plans or programmes before they are adopted. It also gives the public and other interested parties an opportunity to comment and to be kept informed of decisions and how they were made. An early consideration of environmental concerns in the planning process creates an opportunity for environmental factors to be considered explicitly alongside other factors such as social, technical or economic aspects.

The SEA process is broadly comprised of the steps outlined in Figure 7-2. The key stages of the SEA process, and the associated outputs required, comprise:

- **Screening**: to determine the need or otherwise for SEA of a specific plan or programme. *Output required = screening decision*.
- **Scoping**: to identify the aspects of the plan or programme that are relevant to the SEA and the related key environmental issues that need to be considered. *Output required = Scoping Report and consultation with Statutory Authorities*.
- **Environmental assessment and evaluation** of the plan or programme: to identify, predict, evaluate and mitigate the potential impacts of the plan or programme and reasonable alternatives. *Output required = Environmental Report*.
- **Consultation, revision and adoption activities**: to seek public opinion on the draft plan or programme and outcome of the SEA process; influence the content of the final plan or programme and document the outcomes of the SEA process. *Output required = Consultation with the public and Statutory Authorities on the Environmental Report accompanying the draft plan or programme, and the SEA Post-Adoption Statement (i.e. this document), accompanying the final plan or programme.*
- **Post-adoption activities**: subsequent monitoring of the impacts of the plan or programme during its implementation to inform the future revision and SEA of the plan or programme. *Output required = Implementation of SEA monitoring regime.*

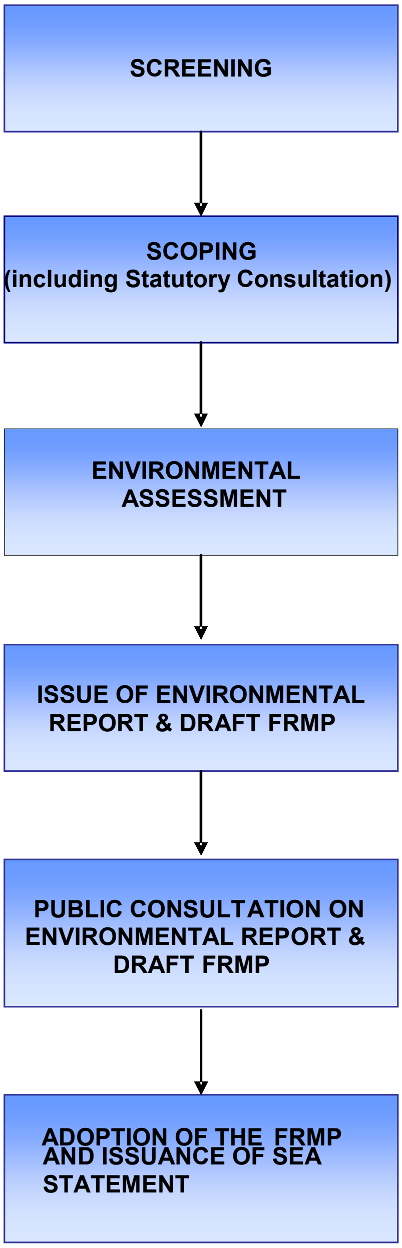


Figure 7-2 Key stages of the SEA process

7.1 HABITATS DIRECTIVE ASSESSMENT PROCESS

The key stages for the AA process include the following:

- Stage 1: Screening Assessment – to address and record the reasoning and conclusions in relation to the first two tests of Article 6(3) of the Habitats Directive. Output = AA Screening Statement.

- Stage 2: Appropriate Assessment – to assess the implications of the Plan for Natura 2000 sites in view of their conservation objectives. Output = Natura Impact Statement.

- Stage 3: Assessment of Alternative Solutions – to examine alternative ways of achieving the objectives of the plan that avoid adverse impacts on the integrity of Natura 2000 sites.

- Stage 4: Assessment Where Adverse Impacts Remain – to assess compensatory measures where, in the light of an assessment of Imperative Reasons of Overriding Public Interest (IROPI) it is deemed that the Plan should proceed.

The Appropriate Assessment (AA) process has been integrated with the SEA process. The requirements and value/sensitivity of the Natura 2000 sites within the Dodder catchment were established at the scoping stage and this information was used to inform the option assessment and SEA process.

7.3 RESULTS OF ASSESSMENT

The focus of the environmental assessment was on the principal components of the Dodder Catchment FRMP, i.e. the preferred flood risk management options, comprising both structural and non-structural measures, recommended for implementation across the Dodder Catchment at both sub-catchment and local levels.

Other recommendations such as the measures proposed to address flood risk to identified Individual Risk Receptors and wider strategic and policy recommendations, for example, the improvement to the hydro-meteorological monitoring network to improve flood forecasting and the application of the new *Guidelines on Spatial Planning and Flood Risk Management* (DEHLG & OPW, 2009), were considered in broad terms. These did not form part of the detailed, multi-criteria option assessment process.

The SEA and HDA processes identified that the following potentially significant effects associated with implementation of the Dodder Catchment FRMP.

Lower Dodder - Donnybrook APSR (hard defences)

- significant negative effects relating to biodiversity, flora and fauna, landscape character and visual amenity;

- significant positive effects relating to population and human health, infrastructure, contamination, cultural heritage and soil;

- minor negative effects relating to social amenity, WFD objectives and fisheries.

Orwell Gardens APSR (hard defences) (option amended in final Dodder Catchment FRMP)

- significant positive effects relating to population and human health, infrastructure, contamination, cultural heritage and soil;

- minor negative effects relating to landscape character and visual amenity;

Shanagary Apartments and Smurfit Site APSR (hard defences) (option amended in final Dodder Catchment FRMP)

- significant negative effects relating to landscape character and visual amenity as well as biodiversity, flora and fauna, though these effects are likely to be less significant since the option was amended between draft and final FRMP stage;
- significant positive effects relating to population and human health, infrastructure and cultural heritage;
- significant positive effects relating to contamination and soil, though perhaps to a slightly lesser extent since the option was amended between draft and final FRMP stage;
- minor negative effects relating to social amenity, WFD objectives and fisheries though these effects are likely to be less significant since the option was amended between draft and final FRMP stage.

St Endas Residential and Tara Hill Residential APSR (hard defences, dredging and removal of weirs)

- significant negative effects relating to WFD objectives, fisheries, biodiversity, flora and fauna and landscape character and visual amenity;
- significant positive effects relating to population and human health, infrastructure and contamination;
- minor negative effects relating to social amenity.

Little Dargle AU (embankments)

- significant positive effects relating to population and human health, infrastructure, contamination, cultural heritage and soil;

Dodder Catchment (support measures on a catcment-wide scale)

- significant positive effects relating to population and human health and cultural heritage.

The combined effects of the identified flood risk management options have been also considered and these are generally neutral or mutually beneficial. However, the combined effects on landscape and visual amenity as well as on social amenity would be negative as increasing areas of these features would be lost with increasing works areas, Also, there might be a combined negative effect on water quality, fisheries and biodiversity, flora and fauna due to multiple sources of pollutants, such as suspended solids, associated with multiple options.

7.4 MITIGATION

Mitigation was recommended in the SEA Environmental Report and Natura Impact Statement in relation to predicted negative effects. The recommended mitigation is summarised below and therefore is adopted as part of this Dodder Catchment FRMP.

7.4.1 Principal mitigation

Further assessment at detailed design stage

- The predicted negative effects should be considered further during the next stage of option development, when details of the option (e.g. visual appearance, alignment of flood defences) can be optimised through detailed feasibility studies and design in order to limit identified impacts on sensitive receptors as well as to maximise opportunities to enhance the environment and social amenity. Where this can be successfully achieved, the implementation of mitigation measures can give rise to a reduction in the significance of the identified negative environmental effects.

- Appropriate survey work should be carried out to inform the detailed design and any necessary mitigation measures.

- Appropriate licences, for example under the Wildlife Acts or derogations under the Habitats Regulations, should be applied for in advance of applying for planning permission or Part 8, and should be accompanied by the relevant survey information.

Avoid impacts by selecting alternative options and/or design solutions

- This has been undertaken for all locations and options through the option development and integrated multi-criteria analysis process. Environmental constraints and opportunities highlighted through the SEA process were used to screen out environmentally unacceptable flood risk management measures at each location and then inform the identification and development of options, prior to the detailed option assessment process. This process ensured that the options selected from the multi-criteria analysis process were generally those that scored highest in terms of the SEA objectives and that the likely impacts of the preferred flood risk management options could potentially be minimised.

7.4.2 General mitigation

General mitigation measures recommended include:

- The objectives of the Eastern River Basin Management Plan should be considered during the detailed design phase;

- Enforcement of relevant existing legislation, for example litter laws, should be considered an important element in the management of flood risk generally;

- In the event of the risk of a flood event in the river all flood relief works should cease;

- The development of a cumulative environmental sensitivity / vulnerability map for the Plan area, highlighting areas more sensitive to cumulative effects, should be considered. Where this exercise has already been carried out for the respective Planning Authorities at a County level in SEA ER's of land use plans, this should be referenced.

7.4.3 Mitigation at the works stage

- Environmentally sensitive techniques should be utilised wherever possible;

- Generally, areas to be coffer dammed and dewatered should be kept to a minimum;

- Except where absolutely necessary, machinery should operate from the bankside and not in-stream;

- Works should only be carried out after a method statement, detailed plans and timing of works have been agreed with NPWS and Inland Fisheries Ireland;

- Works in environmentally sensitive areas should be undertaken outside of the main breeding seasons;

- No activity associated with the project should be undertaken during very wet weather (generally defined as 25mm or more of rainfall in a single day).

- Temporary flood defences should be in place during the course of construction when the removal of existing structures exposes the area to an increased risk of flooding;

- Biodegradable fuels and lubricants should be used where possible;

- Machinery should not be re-fuelled or lubricated near the river;

- Fuels, lubricants and hydraulic fluids for equipment used on the construction site, as well as any solvents, oils, and paints should be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to codes of practice;

- Any spillage of fuels, lubricants of hydraulic oils should be immediately contained and the contaminated soil removed from the site and properly disposed of;

- Waste oils and hydraulic fluids should be collected in leak-proof containers and removed from the site for disposal or re-cycling;

- Raw or uncured waste concrete should be disposed of by removal from the site;

- Wash down water from exposed aggregate surfaces, cast-in-place concrete and from concrete trucks should be trapped on-site to allow sediment to settle out and reach neutral pH before clarified water is released to the river or drain system or allowed to percolate into the ground. Where possible pre-cast concrete or sheet piles should be used;

- Foul drainage from site offices etc. should be connected to a local sewer or removed to a suitable treatment facility or discharged to a septic tank system constructed in accordance with EPA guidelines;

- If temporary toilet facilities are used, the location of these facilities must be suitable and they must be maintained by a licensed contractor;

- Generally, wastes associated with construction, operation and maintenance works should be managed in accordance with national waste legislation where relevant and appropriate;

- Issues that may arise post-construction should be investigated and mitigated;

- Work should be planned to take account of the time of year of previous floods and tide forecasts.

7.4.4 General environmental mitigation

- All projects resulting from the Dodder Catchment FRMP should be subject to appropriate assessment screening and if necessary appropriate assessment;

- No trees should be removed between 1st March and 31st August as per the Wildlife Act (exemptions for trees that pose a significant health and safety risk and trees that are likely to fall into the river and cause a blockage downstream under Irish legislation but this is superseded by European legislation in instances where the tree, for example, provides habitat which is essential to designated species);

- The provision/application of appropriate buffer zones between designated ecological sites and proposed projects associated with the implementation of the Plan should be considered;

- Potential future protected area boundary changes should be considered.

7.4.5 Mitigation in relation to fisheries (from assessment table)

- A Fisheries Enhancement and Rehabilitation Programme should be developed. The application of basic in-stream enhancement techniques to develop suitable spawning and nursery habitats for fish should be considered. This could be achieved through the addition of rubble mats and gravel at carefully selected points. Over-deepening at key points would also be effective in creating holding areas (pools) for older and larger fish;

- Aquatic ecology assessment should be undertaken before works begin. The design of the defences and maintenance regime should consider the requirements of fisheries and possibly the creation of suitable fishery habitat. This could include avoiding carrying out works during fish migration season or incorporating habitat creation in the design;

- Fisheries enhancement and rehabilitation should be considered outside of areas of proposed works as well as within them;

- Fisheries rehabilitation should be carried out with professional expertise and with the assistance and advice of Inland Fisheries Ireland. Local angling groups should be included in the process.

7.4.6 Mitigation in relation to lamprey and salmonids

- The removal of any weirs should be carried out gradually and in stages to prevent the washing away of marginal silt deposits where juvenile lamprey are found as well as the potential displacement of juvenile salmonids;

- No in-stream works, including weir removal should be carried out during the period October to June inclusive without the agreement of Inland Fisheries Ireland;

- Before any area is de-watered, suitable juvenile lamprey habitat, and suitable salmonid nursery habitat in adjacent areas of river should be identified if present;

- Following installation of coffer dams, the enclosed waters should be electrofished by an operator (licensed by NPWS and Department of Communications, Energy and Natural Resources) if lamprey and/or salmonids are present. All lamprey and juvenile salmonids captured should be transferred to selected nearby habitat. All other fish should be released to the river. While awaiting transfer, captured fish should be held in the river in a perforated bin or in an aerated container;

- Pumps used for de-watering should be provided with mesh screens to avoid taking in fish.

7.4.7 Mitigation in relation to birds and bats

- Pre-construction surveys should be conducted by suitable qualified ecologists of all works way-leaves, depot areas, storage areas and other works areas for nesting bird and bat species. Should any important species be found during the surveys, project engineers should be informed and appropriate mitigation measures should be agreed between the surveying ecologist and the project engineers having consulted with NPWS;

- Where possible hedges, trees and riparian vegetation should not be removed during the nesting season (i.e. 1st March to 31st August as per the Wildlife Act).

7.4.8 Mitigation in relation otters and badgers

- Pre-construction surveys should be conducted by suitable qualified ecologists of all works areas for evidence of otters and badgers. Should any of these be found during the surveys, project engineers should be informed and appropriate mitigation measures should be agreed between the surveying ecologist and the project engineers having consulted with NPWS;

- Every effort should be made to ensure that suitable riparian habitat is left along the watercourse to enable the river to act as a wildlife corridor. Where this is not possible mammal ledges and artificial otter holts should be considered.

7.4.9 Mitigation of suspended solids pollution

- Special measures are required to prevent the large volumes of fine sediments which may have accumulated upstream of weirs (identified for removal) from being released into the river and further downstream into the estuary. The method whereby this should be achieved should be agreed with IFI prior to commencement of the works. It is likely that the most effective method would be to remove fine sediment deposits prior to removal of the weir using suction dredging. The work should be carried out only at low flows and silt blankets or other silt filtering measures should be put in place across the river downstream of the works area. Dredged sediments should be disposed of in a location where they cannot erode into adjacent watercourses;

- Where construction of flood defences poses a significant risk of suspended solids and other pollution, the area of the proposed works should be isolated using coffer dams. If de-watering is necessary to allow works to proceed, water pumped from the contained area should be passed through a settlement pond or pre-fabricated settlement tanks with oil interceptor before being discharged to the river;

- For construction activities close to the river bank, eroded sediments should be retained on site with erosion and sediment control structures such as sediment traps, silt fences and sediment control ponds. Sediment ponds and grit/oil interceptors should be placed at the end of drainage channels;

- No in-stream works should be carried out during the period October to June inclusive without the agreement of Inland Fisheries Ireland;
- The removal of sedimats (if used) should occur as necessary when they have become embedded with silt. The frequency at which this will occur is not possible to predict but is likely to be every three to four days during the work phase;
- Bankside silt fences should be replaced regularly;
- In the event of the risk of a flood event in the river, the silt fences will be removed;
- Increased scouring effects of flood defence structures downstream, including within the Liffey Estuary, should be considered.

7.4.10 Mitigation in relation to invasive species

- During the next phase of the study, the detailed design phase, a method statement should be prepared detailing adequate mitigation measures that will be implemented to prevent further spread of alien species within the catchment during the construction phase;
- Invasive species encountered in works phase should be appropriately disposed of.

7.4.11 Mitigation in relation to the maintenance plan

- Protocols should be agreed with all relevant stakeholders in relation to agreeing proactive and reactive maintenance plans for the river in order to resolve potential conflicting objectives. The maintenance plan should be subject to AA to ensure that all future operations are fully compliant with the Habitats Directive.

7.4.12 Mitigation in relation to cultural heritage

- Structures of cultural heritage value which are earmarked for works in the plan should be appropriately restored and not re-instated with concrete. Cultural heritage structures should be preserved as much as possible, including views of them. A conservation architect should be engaged in relation to such works.

7.4.13 Mitigation in relation to landscape

- Landscape Character Assessment should be undertaken at detailed design stage;
- Landscape screening options should be considered at detailed design stage.

7.4.14 Mitigation in relation to cumulative and in-combination effects

- The potential cumulative and in-combination effects of the concurrent implementation of flood risk management options should be considered at detailed design phase. Relevant mitigation measures should be implemented.

7.5 GUIDELINES

The following guidelines should be consulted during the detailed planning of the works phase.

- Requirements for the protection of fisheries habitat during construction and development works at river sites developed by the Eastern Regional Fisheries Board.

- Best practice toolkit of freshwater morphology measures developed by the Freshwater Morphology Programmes of Measures and Standards (POMS) study under the Shannon International River Basin District (ShIRBD) project.

- Good practice guidelines on the control of water pollution from construction sites developed by the Construction Industry Research and Information Association (CIRIA).

- Pollution prevention guidelines in relation to a variety of activities developed by the Environmental Agency (EA), the Scottish Environmental Protection Agency (SEPA) and the Northern Ireland Environment Agency (NIEA).

- Recommendations from the EU with regard to preserving wetlands and green river banks for the natural attenuation of flow http://www.ieep.eu/assets/902/GI_Case_Analysis_4_-_Freshwater_and_Wetlands.pdf.

7.6 OBJECTIVES, TARGETS AND INDICATORS

The following points regarding the objectives, targets and indicators should be considered during the six-yearly review of the Dodder Catchment FRMP:

- for PHH1, safe drinking water and bathing water areas should be considered as objectives;

- for C1, this objective is unclear and while it is included as a climate change objective this is not reflected in the targets or indicators;

- for S1, it is unclear how protecting soil function can be monitored using area at risk from flooding;

- Consideration should be given to separating “Air and Climate” as distinct SEA topics and subsequently in SEA objectives. Whilst it is acknowledged that air can reasonably be screened out, climate issues have potential to impact on flood frequency and magnitude.

7.7 MONITORING

Article 10 of the SEA Directive requires that monitoring be carried out in order to identify, at an early stage, any unforeseen adverse effects due to implementation of a plan or programme, and to be able to take remedial action.

In response to this requirement, a monitoring framework has been proposed for the Dodder Catchment FRMP, based on the SEA objectives and their associated framework of indicators and targets, utilising the data obtained as part of the SEA.

The purpose of the monitoring is twofold: to monitor the predicted significant negative effects of the Dodder Catchment FRMP; and to monitor the baseline environmental conditions for all SEA objectives and inform the six yearly update of the Dodder Catchment FRMP necessary to meeting the requirements of the EU Flood Directive. Regular monitoring will also help to identify any unforeseen effects of the FRMP and ensure that where these effects are adverse, action can be taken to avoid, reduce or offset them.

Monitoring will commence as soon as the Dodder Catchment FRMP is implemented. The framework itself will be reviewed and revised during the six-yearly review of the Dodder Catchment FRMP with the monitoring findings also being recorded at this stage. The review will take into account new available monitoring data/methods and any improved understanding of the environmental baseline and receptors potentially affected by the Dodder Catchment FRMP.

Where existing monitoring is not already being undertaken and is required to support the implementation of the Dodder Catchment FRMP; the OPW, Dublin City Council, Dun Laoghaire – Rathdown County Council and South Dublin County Council will be responsible for identifying an appropriate monitoring body and ensuring that the monitoring is carried out.

The monitoring framework is outlined in Appendix F.

8 CATCHMENT FLOOD RISK MANAGEMENT STRATEGY

This chapter of the Dodder Catchment FRMP details the measures and policies that should be pursued by the local authorities and the OPW to achieve the most cost-effective and sustainable management of flood risk within the Dodder Catchment in the short, medium and long-term.

8.1 INTRODUCTION TO THE STRATEGY

Viable structural and non-structural measures and options for managing identified flood risk in the Dodder catchment have been identified through the option assessment process. This is described in the Chapter 6 and the viable options are listed in Table 6-5.

This FRMP does not prescribe solutions to all of the flooding problems that exist in the catchment; that would be neither feasible nor sustainable. What it does is it:

- identifies the measures and flood risk management options that have been shown to be viable in flood risk management terms by the analyses undertaken;
- sets the prioritisation/phasing in terms of development of these options;
- indicates the further studies and work needed to progress implementation of options; and
- identifies the requirements for future monitoring and review of the FRMP.

In addition, the FRMP discusses the role of ‘partners’ in its implementation, and also the relevance of wider catchment issues such as land use and land management.

With an understanding of flood risk and its quantification, the strategy for flood risk management seeks to mitigate the impacts of flooding on people’s lives, economic activity, the environment and heritage, where it is feasible (technically, economically, socially and environmentally) and sustainable to do so. Inevitably, this approach will not remove all flood risk and, indeed, it would be wrong to do so because that would be ignoring natural processes and would be unsustainable.

A flood risk management strategy necessarily incorporates both non-structural and structural measures, identifies all partners/stakeholders, and deals with both present day and potential future flood risk. The findings and recommendations for the Dodder catchment within this FRMP will have to be considered in a national context and assigned an order of priority at that level, subject to timescale considerations.

Non-structural measures, such as flood forecasting and public awareness activities, are the most important, if not essential, part of the strategy, which can usually be implemented in the short to medium-term at relatively low cost and independent of prioritisation at a national level. They can have benefits in the short, medium and long-term, and, importantly, do much to increase public awareness of flood risk. Collectively, non-structural measures reduce the risk of flooding and there are intangible social benefits through increasing awareness of flood risk and preparedness of the public.

Many localised flooding events occur due to the blockage of watercourses with debris resulting in a decrease in the capacity of the river channel or culvert. Additionally, existing flood defences can fail if not properly maintained resulting in rapid inundation of defended areas. The development of a well-structured, cost effective and proactive maintenance programme will therefore minimise the occurrence of these type of events and forms a key part of the FRMP.

Structural measures are assigned prioritisation in the Dodder catchment on the basis of the option assessment and MCA processes. The overall duration for implementation of the FRMP is provided in Section 8.8, along with an indicative programme. The programme is subject to consideration of the Dodder catchment within the national context, and to budget availability, which will be an important determining factor.

Structural measures and flood alleviation schemes receive most public attention when a FRMP is published, and public perception is often along the lines that non-structural measures do not prevent flooding and are therefore of less value. Flood alleviation schemes are visible and they give the security of protection to the design standard; but they can be expensive and, usually, require on-going operation and maintenance. Figure 8-1 shows that any such scheme will require a pre-construction period for detailed study, investigation and design, which could be quantified in years for major schemes such as defences for a large town or city.

As a pilot study for catchment-level flood risk assessment and management in Ireland, it is important to incorporate monitoring, review and evaluation of the components into this FRMP. This should be established at an early stage in the programme such that the findings can be fed through to other similar studies elsewhere in the country.

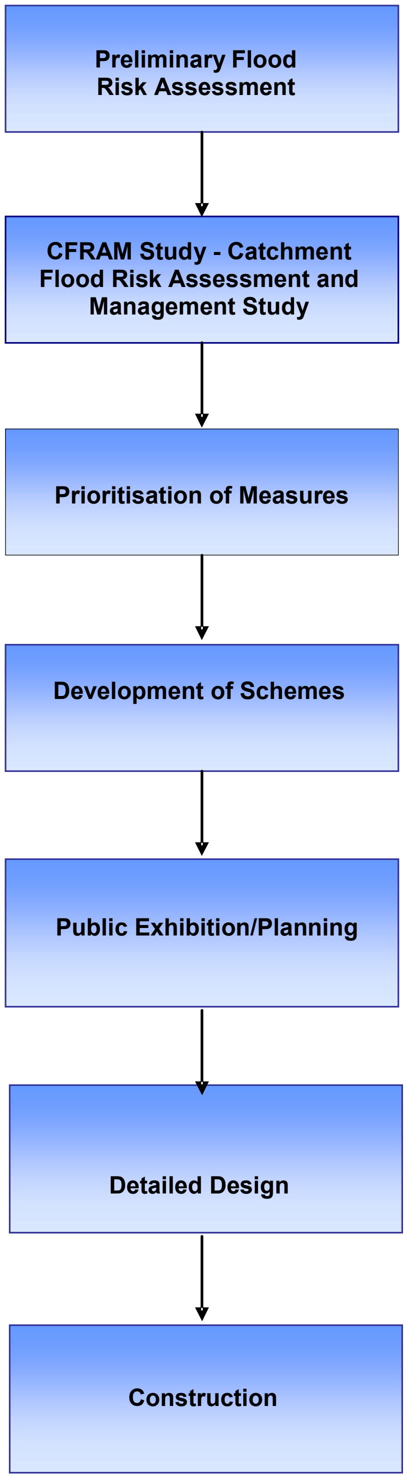


Figure 8-1 Flow chart showing the process through to construction for a scheme

8.2 COMPONENTS OF THE DODDER CATCHMENT FRMP

The assessments detailed in Section 6 led to a list of options to be pursued to complement the existing defences described in Section 5. These FRMP components are summarised in Table 8-1 with their locations illustrated in Figure 8-2.

At catchment level, tidal and/or fluvial flood forecasting systems are proposed for widespread coverage in conjunction with public awareness and flood warning programmes; in addition to maintenance, monitoring and policy measures such as spatial planning and flood planning.

The maintenance element of the Dodder system and its defences is a key support measure to both existing and proposed hard defences and to the safeguarding of channel conveyance. As part of the Dodder CFRAM Study a maintenance plan was prepared incorporating a sediment transport model which assists in reviewing the geomorphic changes that occur within the catchment. This plan has reviewed the existing maintenance programmes undertaken by the three Local Authorities and the riparian landowners and proposed a strategy to manage maintenance across the catchment more effectively. This plan should be implemented, in conjunction with the components of this FRMP as listed below, in order to reduce the risk of debris obstructing channel flow and/or the failure of flood defences.

At Analysis Unit level (Little Dargle) one option consisting of earth embankment flood defences is recommended.

Within four APSRs/flood cells proposals for flood defences are recommended (Lower Dodder – Donnybrook, Shanagarry Apartments and Smurfit Site, Orwell Gardens and St Endas and Tara Hill), in one case augmented by channel conveyance (at St Enda's & Tara Hill).

Table 8-1 Components of the FRMP

Spatial Scale	Preferred Option	MCA Score	BCR	Cost € million	Comments
Catchment Level					
Dodder Catchment	Flood forecasting systems with public awareness & flood warning programmes along with maintenance, monitoring and policy measures	7.32	1.62	1.065	To provide coverage for Whitechurch, Little Dargle, Dundrum Slang and Dodder
Analysis Unit					
Little Dargle	Hard defences	19.45	5.1	0.015	
Area of Potential Significant Risk/Flood Cells					
Lower Dodder - Donnybrook	Hard defences	8.20	1.1	9.03	
Shanagarry Apartments and Smurfit Site	Hard defences	10.22	1.15	3.23	
Orwell Gardens	Hard defences	20.37	2.13	0.604	
St Endas and Tara Hill	Hard defences with improvement of channel conveyance	1.04	1.07	1.85	

Description sheets for the options to be pursued, which give qualitative and quantitative information on the proposals, have been prepared for each component of the FRMP. These are included as Appendix E and further discussion of the proposals follows.

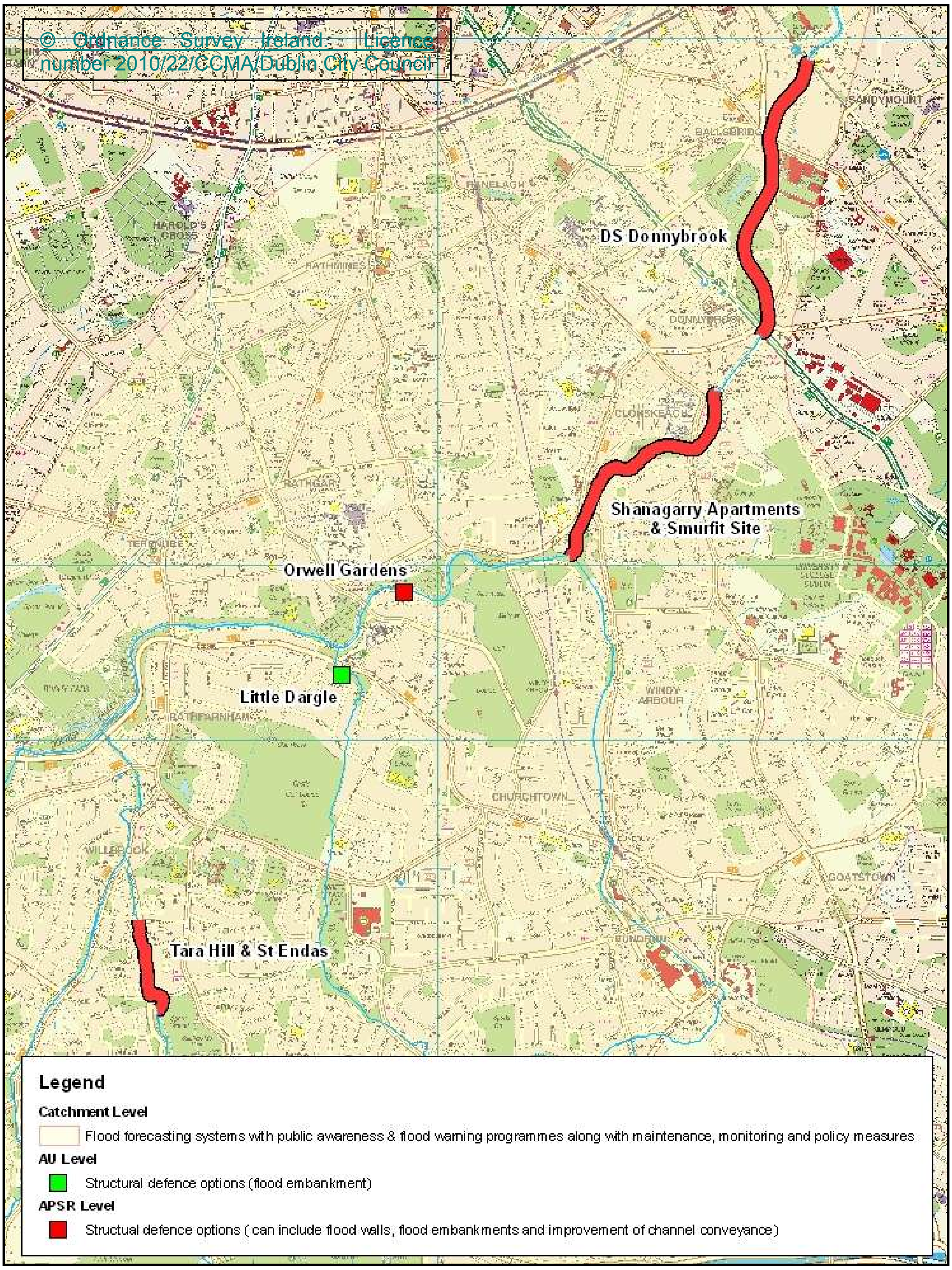


Figure 8-2 Location of Analysis Unit and APSR options recommended in the Dodder Catchment FRMP

8.3 NON-STRUCTURAL MEASURES

8.3.1 Flood forecasting

Coastal flood forecasting and warning, together with a public awareness campaign throughout the Dodder catchment, is a component of the plan. There is good reason to pursue this approach as part of the Dodder Catchment FRMP because of the potential benefits of local authorities, emergency services and the general public taking action to prepare for, and mitigate, the impacts of flooding. It must be realised, however, that the reduction in economic damages from such an approach will generally be small. Other measures, such as individual property protection, flood resilience measures, and/or flood defence works are required to provide an improved standard of protection to ‘at risk’ assets.

In fact a coastal flood forecasting and monitoring system is already in operation in Dublin Bay as are partial systems for fluvial (several river gauges) and pluvial forecasting (an increasing number of linked rain gauges). This FRMP’s proposals are consistent with these current arrangements.

The coastal flood warning system for Dublin Bay is based on hydrodynamic modelling, fed with meteorological forecasting data provided by Met Éireann and is a purely tidal-surge forecasting model, and does not include any capability for fluvial flood forecasting. Accurate fluvial water level forecasting would require an integrated forecasting system with both tidal-surge and fluvial forecasting capacity.

The OPW have undertaken a strategic review of options for flood forecasting and warning (FWW) in Ireland with a view to:

- examining the potential benefits that FFW could achieve in Ireland;
- identifying and assessing the options for the delivery of such a service, including the associated resource requirements; and
- developing an appropriate and sustainable strategy (including consideration for the potential impacts of climate change) for FFW in Ireland.

A preliminary analysis conducted under this review indicates that the Annual Average Damages from fluvial and tidal flooding are approximately €171-195 million (at 2010 prices) and that the potential tangible benefits from the provision of an effective flood forecasting and flood warning service across the country could reduce these damages by at least €8 million annually.

The review included detailed examination of the existing context of, and current arrangements for, flood forecasting and flood warning in Ireland and six other countries. This included an assessment of all currently operational and trial flood forecasting and warning systems, from local/catchment scale systems such as the flood forecasting system for the Munster Blackwater at Mallow, to national and international systems, such as the storm surge forecasting system developed under the Irish Coastal Protection Strategy Study and the European Flood Alert System (EFAS). This was complemented by a review of international best practice, emerging innovations, and identification of options that could be applicable / transferrable to Ireland.

The review concluded that flood forecasting and warning is a major investment in terms of staffing, equipment and running costs. It requires a dedicated core team and also a stepped increase in resources during flood events. Significant investment is also needed in emergency response and public awareness if the warnings are to be effective (i.e. acted upon).

There are significant opportunities for Ireland in developing a world-leading flood forecasting and flood warning system helped by the:

- CFRAM Studies;
- The existence of few legacy systems;
- New technology (especially in uncertainty modelling);
- Ability to learn from good practice elsewhere;
- Ability to identify long-term costs and benefits;
- Possible joint working of meteorologists and hydrologists;
- Cross-border collaboration.

8.3.2 Other non-structural/minor & localised modifications

There are other non-structural/minor and localised modifications not included in the option assessment process that are important components of a flood risk management strategy. Inter-alia, these include:

i. Hydro-meteorological data collection network

Future review and study may identify improvements to the hydro-meteorological data collection network. It is recommended that a joint ESB, EPA and OPW review is undertaken to ascertain whether further collaboration is possible in accessing, storing and disseminating data from existing hydrometric gauges in the Dodder catchment. In particular, a further improved and expanded network may be a requirement for effective flood forecasting. In addition to the above, the existing hydro-meteorological data collection network should also be maintained.

ii. Spatial planning and development management

Inappropriate development in floodplains, or development that can increase runoff rates and volumes, can create flood risk to the properties being built and potentially increase the risk to other areas. The Guidelines on the Planning System and Flood Risk Management should be implemented in full by the planning authorities to ensure that flood risks are not created or made worse.

The flood maps produced through the Dodder CFRAM Study set out flood-prone areas, and indicate the flood levels and flows, within many parts of the Dodder Catchment. Further flood maps will continue to be produced by the OPW through the CFRAM programme. Planning authorities and developers should make use of these maps to assist with the Flood Risk Assessment (FRA) required in the preparation of development, local area and other plans, and in the preparation and assessment of planning applications.

Planning authorities also should have particular regard to proposed flood risk management measures set out within this plan, to ensure that the implementation of the proposed measures is not prevented or impeded.

Planning authorities should consult with the OPW in relation to the maps and how they might be used, and for general support and advice in relation to flood risk and the implementation of the Guidelines, when preparing development or local areas plans.

iii. Public awareness and education

A widespread public awareness campaign will be necessary to inform the public on the level of risk in their area, what is planned to be done about it, what self-help measures they can take and where they can find information. When implemented, information on flood forecasting and warning systems, and how the public can benefit from them, will be broadcast. The campaign will make use of various media, such as public meetings; notices in public buildings, newspapers and on the radio and television, and webpages. For this to be effective, adequate technical knowledge and support will be necessary to implement the campaign and respond to queries.

National and district-level awareness raising activities have taken place, and are planned for the future, under the CFRAM programme. A national website and district-level websites have been established. District-level newsletters are prepared periodically. Lists of national, regional and local stakeholders are maintained and notification of CFRAM activities is provided to all stakeholders. A series of public consultation days for each APRS (or Area for Further Assessment (AFA)) within the CFRAM programme are planned in relation to the draft flood mapping, draft flood risk management options and draft district-level FRMPS. These will be promoted locally in newspapers and on radio.

Another useful source of information is the ‘**Plan-Prepare-Protect’** webpage operated by OPW, www.flooding.ie. The website provides practical advice in relation to assessing whether a home/property is at risk from flooding, preparing for a flood, some protection measures that can be taken, how to clean up after a flood and who to contact for more information or in an emergency. The OPW have also updated their ‘plan, prepare, protect’ booklet in 2014 which can be found online and in the offices of Local Authorities.

iv. Individual property protection

Individual property protection will be required to fully realise the potential benefits of flood forecasting and warning, especially for isolated properties in areas that will not be defended through implementation of the FRMP proposals. This option may also be attractive to some property owners in APSRs where defence scheme implementation is a low priority.

There is a multitude of proprietary products on the market, with some information available on the www.flooding.ie webpage. Products can provide flood resistance at the time of a flood, such as those that seal door openings and airbricks. Other individual property protection measures include those that increase the resilience of a property if flooded, such as the replacement of wooden flooring with concrete, raising of electrical wiring and sockets to above flood level, replacing carpets with waterproof floor covering, etc.

Adequate technical knowledge and support will be necessary to implement these measures and respond to queries from the public. Funding for individual property protection remains the responsibility of the property owner.

v. The wider aspects of land use management in the catchment

Existing land use, which is predominantly agricultural, is not a major contributing factor to flood risk in the Dodder catchment. Predicted future change is not expected to change the situation significantly, although increased afforestation could marginally reduce flood risk in some areas. Livestock grazing and arable farming could vary with the potential impacts of climate change but, unless this reduces ground cover, the change to flood risk would be limited.

Urban expansion is expected, but not at a significant scale. The guidance on spatial planning and management should be followed by planning authorities, to prevent inappropriate development. Attention to planned development extending the urban boundaries will be especially important to prevent loss of floodplain storage and conveyance. SuDS implementation is already a recommendation within the catchment.

vi. Other

Other non-structural measures not included in the option assessment process that are important components of a flood risk management strategy include:

- Technical training for planners;
- Determine Defence Asset Monitoring and Maintenance Programme;
- Regular programme of inspection, removal of debris from channels etc.

vii. Institutional strengthening

OPW, Dublin City Council, Dún Laoghaire-Rathdown County Council and South Dublin County Council will be key players in the development and implementation of the non-structural measures. OPW has much of the specialised technical knowledge at present but it will be important to increase the technical resource capacity in the local authorities to support the successful implementation of the national programme of catchment flood risk assessment and management studies. The strengthening of the technical flood risk management capacity within the local authorities can also support the development of local flood relief works, as well as the effective implementation of the Guidelines on the Planning System and Flood Risk Management.

8.4 STRUCTURAL MEASURES

Structural measures form the preferred options to be pursued for the Little Dargle Analysis Unit and the four APSRs/flood cells in the Dodder catchment where the flood risk is greatest. Details of the preferred options to be pursued are given in the option description sheets included as Appendix E.

Flood defences are proposed in the form of flood walls and/or embankments, with the type of defence determined by space availability, defence height and visual impact. One preferred option (at St Enda's & Tara Hill) includes improvement of channel conveyance along with flood walls. Other structural measures assessed generally resulted in a lower MCA score than an option based solely on walls and embankments, nevertheless, these will be investigated in more detail as components of a scheme at the next stage of development in order to optimise the solution.

Improvement in channel conveyance, usually to remove minor or localised constrictions that could limit flow, may be considered if not already proposed, as part of the preferred options' works, at detailed design stage.

For any structural works, operation and maintenance procedures should be prepared and budget provision made. The cost estimates include for this and it will be important to continue the effective functioning of any structure and prolong its design life. Flood walls need little attention other than periodic inspection and repair as necessary. Embankments are susceptible to settlement and crest degradation where they are accessible to people, animals or vehicles, and they need more frequent inspection and rectification of any defects. Where defences incorporate gates or other mechanical components, regular inspection and maintenance will be provided. Dredged channels can silt up again reducing the channel capacity. Regular inspection and proactive maintenance will be required to sustain the channel conveyance.

8.4.1 Preferred Option details

At Analysis Unit level a preferred option was found for the Little Dargle which consists of 32m of earth embankment approximately 1m high at the downstream extent of the stream. No other preferred options were found at AU level and the level of assessment was therefore focused on the smaller APSR/flood cell level.

Several preferred options were found at APSR/flood cell level. On the Dodder River the area downstream of Donnybrook, excluding the existing protected areas from the current and scheduled flood defences, was considered. A preferred option was found which consists of 1,683m of flood wall and 351m of earth embankment on both sides of the river bank averaging 1.2m high. Further upstream the area encompassing Shanagarry apartments and the Smurfit site was considered at APSR level and a preferred option found. This option consists of 250m of flood wall and 120m of earth embankment on both sides of the river bank. One other area along the Dodder River was identified at APSR level for which a preferred option was found, Orwell Gardens. This option consists of a short 24m section of flood wall and 29m of embankment.

All of the Dodder tributaries were assessed and various areas identified at APSR level. Of these, one APSR on the Whitechurch Stream (called Tara Hill & St Endas) produced a preferred option. This option consists of 285m of flood wall, averaging 0.7m high, 702m of dredging along the stream and the removal of two weirs.

8.4.2 Existing Defences

The Study has identified a number of existing defence assets on the Lower Dodder. Proactive maintenance of these defences should be undertaken where relevant.

8.5 INDIVIDUAL RISK RECEPTORS

Flood risk management of the individual risk receptors is subject to discussion with their owners to agree an appropriate course of action and responsibility for it. From Section 6, it is unlikely that flood protection for individual assets would be justified, except if they are within the coverage of the preferred options for the respective APSR or Analysis Unit.

Several of the risk receptors are in the Lower Dodder, Donnybrook APSR, where the preferred option is for permanent flood defence works and, if implemented, this will solve the problem for the receptors or infrastructures at risk. The proposed timescale for implementation of preferred option is by 2015. The owners of the assets have the option to take action to fit their own programme and resources.

The Dundrum Shopping Centre and theatre, ESB sub-station, Dodder Road Lower and N81 Tallaght Bypass do not fall within the protection of APSR defences and no positive BCR option could be identified for these individual risk receptors.

Proactive planning for diversion arrangements for flooded roads and alternative bus services for flooded railways will alleviate the situation for transport infrastructure. For utilities infrastructure such as water and waste water treatment plants, flood alleviation can be achieved through provision of flood defences, maintenance of existing defences, or emergency planning for closure of the plants during floods and alternative supply arrangements, or even closure and re-location of the plant. The owners of the receptors, usually the local authorities, will be consulted to agree the action to take.

Table 8-2 anticipates the possible outcome of discussions of the risk receptors with their owners, and adoption of the FRMP components in Table 8-1.

The maintenance element of the system and its defences is a key support measure to both existing and proposed hard defences and to the safeguarding of channel conveyance.

The purpose of this maintenance plan is to provide the participating Local Authorities with a tool to enable them to direct risk based detailed inspections and prioritised maintenance programmes to manage effectively the reaches of the Dodder within their respective operational controls.

Table 8-2 Possible Solutions for Individual Risk Receptors

Risk receptor	Owner	AU/APSR	Possible solution
AIB Centre Ballsbridge (off Merrion Road and Serpentine Road)	AIB Group	Dodder/DS of Donnybrook	APSR defences
AVIVA Rugby & Soccer Stadium	IRFU & FAI (LRSDC)	Dodder/DS of Donnybrook	APSR defences
Royal Dublin Society (RDS)	RDS	Dodder/DS of Donnybrook	APSR defences
Shelbourne Park Dog Track	Irish Greyhound Board / Shelbourne Greyhound Stadium Limited	Dodder/DS of Donnybrook	APSR defences
Marian College School	Marist Brothers managed by the Board of Management	Dodder/DS of Donnybrook	APSR defences
American, Israeli and Czech Republic Embassy's on Northumberland Road.	Respective countries governments	Dodder/DS of Donnybrook	APSR defences
Church of Ireland, Anglesea Road.	Church of Ireland	Dodder/DS of Donnybrook	APSR defences
Dublin Bus, Beaver Row, Donnybrook.	Dublin Bus	Dodder/DS of Donnybrook	APSR defences

Risk receptor	Owner	AU/APSR	Possible solution
Dart Line at Lansdowne Road Bridge and Serpentine Avenue crossing.	Irish Rail	Dodder/DS of Donnybrook	APSR defences
Merrion Cricket Pitch Occasionally used as parking for events in RDS.	Merrion Cricket Club	Dodder/DS of Donnybrook	APSR defences
Leinster and Old Wesley Rugby football ground, Donnybrook.	Old Wesley RFC	Dodder/DS of Donnybrook	APSR defences
Major Roadways disrupted. Shelbourne Road, Merrion Road, Northumberland Road, Donnybrook Road (N11), Stillorgan Road (N11), Clonskeagh Road.	Local Authority	Dodder/DS of Donnybrook	APSR defences
Dundrum Shopping Centre & Theatre	Crossidge Developments	Dundrum Slang	Localised flood defences.
ESB sub-station, Dodder Road Lower,	ESB	Dodder	Localised flood defences or relocation of sub-station. Short term arrangements for temporary road diversion.
N81 Tallaght Bypass	Local Authority	Tallaght	Short term arrangements for temporary road diversion.

8.6 ENVIRONMENTAL ASSESSMENT OF THE PLAN COMPONENTS

The integration of the SEA and HDA processes within the development of the Dodder Catchment FRMP has ensured that:

- Key environmental issues, constraints and opportunities within the Dodder Catchment relating to flood risk management were identified at an early stage of the plan development process, enabling:
    - Environmentally unacceptable flood risk management measures to be screened out from further consideration at the outset; and
    - The development of flood risk management options to avoid potential environmental impacts where possible.
- The preferred options selected following the MCA process were generally those that scored highest in terms of the SEA objectives so that the likely environmental impacts of the preferred flood risk management options are minimised.

- The predicted effects of the Dodder Catchment FRMP were clearly identified and recommendations were made to address these in this final Dodder Catchment FRMP.

- Effective and comprehensive stakeholder and public consultation was undertaken throughout the Dodder CFRAM Study to inform the plan development process and the SEA.

8.7 PLUVIAL FLOODING

Pluvial flooding problems have been experienced in some urban areas, including around Dublin City. As the urban areas developed drains and rivers flowing through what is now the Dublin City were taken underground and have been subsumed into the main urban drainage network for this area.

The problems occur following heavy, intense rainfall, when surface water cannot drain to the river because of high water levels in the receptor. As a result, drains can become surcharged leading to the risk of localised flooding of streets and property, and there is also the risk of manhole covers being lifted and displaced by pressure build up in the drains, which in turn leads to a health and safety risk.

Dublin City Council is one of eleven partner organisations, drawn from eight European cities, which form the Interreg IVB flood risk management good practice project known as the FloodResilienCity (FRC). One of the main areas of technical interest of the FRC project is Pluvial Flood Risk Management, including pluvial flood risk mapping and modelling, the development of pluvial flooding forecasting systems and a Pluvial Flood Risk Management Strategy. The forecasting system will be compatible with the national flood forecasting system currently under review by the OPW. The FRC started in 2008 and is due to run until April 2012.

The Greater Dublin Strategic Drainage Study (GDSDS) was commissioned by the seven Local Authorities in the Greater Dublin Region. It began in June 2001 and was completed in April 2005. The GDSDS Final Strategy provides a consistent policy framework and standards in relation to development requirements, stormwater management, infiltration and exfiltration, drainage of basements, considerations of the effects of climate change and a coherent environmental policy. The Final Strategy also makes detailed and comprehensive recommendations on infrastructure needs. The Greater Dublin Regional Drainage Project (GDRDP) will provide long-term drainage solutions in the Greater Dublin Area by implementing the recommendations of the GDSDS Final Strategy and the SEA of the GDSDS.

Many surface-water drainage outfalls are fitted with flap-valves to prevent flow from the rivers backing up the drains, and it is these that also stop the drains discharging when river levels are high. It is important that all drainage outfalls and culverts are fitted with flap-valves and that these are maintained in good working order. If the risk of pluvial flooding is to be reduced, the basic options would be:

- Pumping installations to pump from the drains, over the top of any defences and into the river; and

- Increased storage capacity and control in the drainage system such that it can cope with the volume of surface water drainage until water levels in the receptor subside.

As part of the Dodder CFRAM Study, an assessment of the urban accommodation works was undertaken to identify critical drainage infrastructure susceptible to pluvial flooding risk.

Neither of the above options provides a cheap solution, but increased storage capacity in the drainage system would be logistically very difficult and costly, especially in Dublin City. Further detailed study would be required to quantify the problems and to decide on an appropriate course of action.

At a wider level, development planners and managers must be made aware of this problem and ensure that it is not exacerbated by new development. Compliance with the planning guidance and inclusion of source control and sustainable drainage systems (SuDS) will be a necessary requirement.

8.8 PRIORITISATION AND IMPLEMENTATION OF THE FRMP

8.8.1 Prioritisation

The process for identifying potential flood risk management options and their evaluation through the MCA process was thorough and detailed for this level of catchment study. It was designed and tested taking account of technical, economic, social, environmental and heritage criteria to give confidence in the output.

Logically, the preferred options with the highest overall MCA score should be the most attractive options. These therefore provided the basis for prioritisation, but this was then refined and agreed between key stakeholders.

It will be 2015 before all CFRAM Study within Ireland are complete and only then will it be possible to do a full national prioritisation of all potential works. Notwithstanding this, it is reasonable for viable works, including structural schemes, to be initiated in advance of this with a view to progression to full scheme development. As cost plays a part in final decision-making, the flood defences for the Dodder catchment, with a total estimated cost in the order of €20 million, will be subject to governmental scrutiny and decision-making.

Lower cost measures, such as minor structural protection works and non-structural measures, may be implemented in the short to medium term, as they may be deliverable within existing budgets and take less time than major schemes to develop and implement.

Minor schemes - those with costs less than €500,000 - are attractive and will proceed under the recently introduced “Minor flood mitigation works and studies” programme.

An indicative programme for implementation of the Dodder Catchment FRMP is set out, with timescales suggested according loosely with EU Directive Cycles, namely:

- high priority = first phase: implementation to 2015;
- medium priority = second phase: 2016 to 2022; and
- low priority = third phase: 2023 onwards.

These timescales, particularly after 2016, may change due to economic conditions in the country and also where flood risk management fits in national priorities.

In summary, development of options beyond the CFRAM Study stage will be based on MCA scores, with priority being given to the lower cost options as well as those that have been demonstrated to be most cost-beneficial.

8.8.2 Proposed implementation

The proposed phasing for implementation of the FRMP for the Dodder Catchment is given in Table 8-3.

Budget availability will be the key factor influencing the implementation of the plan. Nevertheless, a range of structural works can be funded and implemented in the short-term, in advance of a full national prioritisation of all potential works in 2015. This includes high priority works at Donnybrook, St Enda's & Tara Hill, Little Dargle and Orwell Gardens. The development and implementation of non-structural measures, refined outline-design for a scheme at Smurfit Papermills to Shanagarry Apartments, can also proceed in parallel with these works, with construction scheduled in the medium-term (post 2016).

Whilst structural works are not justified in all locations with at risk properties or individual risk receptors, these will be within the coverage of public awareness programmes, policy measures, the tidal flood forecasting system for Dublin Bay and potentially future fluvial flood forecasting systems.

In addition to budget, human resource capacity will be a factor in deciding the rate at which the Dodder Catchment FRMP can be implemented. Institutional strengthening will be needed.

8.8.3 Future scenarios

Currently, flood defences are considered the overall preferred option for managing the flood risk in five portions of the Dodder catchment. The impact on fluvial flood flows and sea level rise are accommodated within the freeboard allowance of these structures. If and when climate change impacts occur, a full and detailed feasibility review of defences and other management measures would have to be undertaken.

8.8.4 Other Localised Works

The Dodder CFRAM Study is a catchment-scale study, and the Dodder Catchment FRMP focuses and proposes solutions to the areas within the catchment that have been found to be at significant flood risk. It is however recognised that local flooding problems do exist that have not been addressed within this plan. Such problems can be addressed at a local level, such as through the OPW-funded 'minor flood mitigation works and studies' programme, and the fact that such areas are not addressed within the plan does not preclude action in parallel to the implementation of the plan. Local actions taken should however consider in full the hazard and risk information available and should not impact on the implementation of the plan. They should also take account of the environmental issues and objectives identified in the SEA.

8.9 MONITORING, REVIEW AND EVALUATION

The Dodder Catchment FRMP will be reviewed on a six-yearly cycle. For the review to be effective, systems will be set up to provide data with which to assess performance in relation to the original Plan content and the information on which it is based, including, inter-alia:

- continued collection and analysis of hydro-meteorological data for improved flood flow and frequency analysis; similarly for tide level data;

- in the event of a flood, either fluvial or tidal, recording the event with photographs, peak water levels, duration, effectiveness of existing defences and/or measures implemented under the Plan, including flood forecasting;

- monitoring of compliance with the planning guidance in relation to flood risk, including use of the flood maps in spatial planning and development management;

- monitoring of land use change and management to establish if it is significant in terms of flood risk and needs to be taken account of in the FRMP;

- monitoring institutional capacity, both technical and quantity, in relation to the FRMP programme and standards, and initiate strengthening as necessary; and

- reviewing the development of FRMP components, in particular their costs, and updating the cost database;

Review and monitoring will be an on-going exercise and lessons learnt will be taken account of in the national CFRAM programme. Lessons learnt will be acted on once they are confirmed and not held back until a six-yearly review.

Developments along the Dodder to date:

- Dublin Coastal Flood Protection Project 2008;
- Works Downstream of the Lansdowne Road (Newbridge bridge) completed 2007 – 2010;
- Lansdowne road (Newbridge bridge) to Irish Rail Bridge at Lansdowne, works are at planning stages;
- Raising of Lansdowne bridge (Newbridge bridge) and London bridge parapets are at the planning stages;
- Upstream of the Irish Rail bridge to Herbert Park Hotel bridge, This phase is at tender stages for the appointment of a consultant who is to be engaged to carry out the detailed design for the construction of defences, as per the Dodder Catchment Flood Risk Management Assessment Plan.

Table 8-3 Phasing of the Dodder Catchment FRMP

<table>
<tr><th>2011</th><th>2012-2013</th><th>2014-2015</th><th>2016+</th><th>Who</th><th>Estimated Cost</th></tr>
<tr><td colspan="5">Non- Structural Options</td><td rowspan="2">0 K</td></tr>
<tr><td>Undertake the Strategic Review of Flood Forecasting & Warning.</td><td colspan="2">Implement findings of Strategic Review of Flood Forecasting and Warning.</td><td>Operate and maintain flood Forecasting and Warning Systems.</td><td>DCC
SDCC
DLRD
(OPW)</td></tr>
<tr><td colspan="4">Operate and maintain Dublin Tidal Predictions, through Dublin’s flood Forecasting, Warning Systems (Triton system) and Tide watch, and carry out any upgrades.</td><td>DCC
(OPW)</td><td>50 K</td></tr>
<tr><td colspan="4">Enhance local awareness and education. Maintain, review, update, and practice flood event response plans.</td><td>DCC
SDCC
DLRCC
(OPW)</td><td>0 K</td></tr>
<tr><td colspan="4">Implement the Guidelines on Spatial Planning and Flood Risk Management (2009).</td><td>DCC,
SDCC,
DLRCC</td><td>0 K</td></tr>
</table>

<table>
<tr><th>2011</th><th>2012-2013</th><th>2014-2015</th><th>2016+</th><th>Who</th><th>Estimated Cost</th></tr>
<tr><td colspan="4">Bohernabreena Dam and Spillways, regularly structurally inspect the dam and spillways, Manage and Monitor levels.</td><td>DCC</td><td>0 K</td></tr>
<tr><td colspan="5">Non- Structural Options (cont.)</td><td rowspan="2">0 K</td></tr>
<tr><td colspan="4">Maintain, coordinate and operate Hydrometric Monitoring Equipment where required. Located at Orwell Road, Beatty's Cottages, Alexandra Basin, Bohernabreena, Frankfort Ave (DLRD), adj. Tuning Fork Public House, Owendoher (SDCC), any existing and new rain gauges.</td><td>DCC
SDCC
DLRCC
EPA</td></tr>
<tr><td colspan="5">Existing Flood Defences</td><td rowspan="2">0 K</td></tr>
<tr><td>Determine defence asset monitoring and maintenance programme</td><td colspan="3">Proactive maintenance of existing defence assets.</td><td>DCC
SDCC
DLRCC
(OPW)</td></tr>
<tr><td colspan="5">Individual Risk Receptors</td><td rowspan="2">0 K</td></tr>
<tr><td colspan="4">Inform owners and operators of interim risk assessment and/or management measures as appropriate, ESB substation at Lower Dodder Road, Irish Rail Lansdowne Bridge, numerous embassies, RDS, AIB bank, Aviva stadium, Shelbourne Park Greyhound Stadium etc.</td><td>DCC
SDCC
DLRCC
(OPW)</td></tr>
<tr><td colspan="5">Catchment Flood Risk Management Plan (FRMP)</td><td rowspan="3">0 K</td></tr>
<tr><td rowspan="2">Following public consultation, complete FRMP and seek adoption by all the 3 local authorities.</td><td colspan="3">Implement the various recommendations of the FRMP</td><td rowspan="2">OPW DCC
SDCC
DLRD</td></tr>
<tr><td></td><td>In 2015 review the FRMP, taking account of any changes and / or new information on possible impacts of climate change.</td><td>In 2021review the FRMP, taking account of any changes and / or new information on possible impacts of climate change.</td></tr>
</table>

2011	2012-2013	2014-2015	2016+	Who	Estimated Cost
Liffey River to Lansdowne Road (Newbridge Bridge)					500 K
Obtain Part 8 planning permission for the raising of the Bridge Parapets on Lansdowne Road (Newbridge) and London Bridge bridges	Design and construct the raising of the bridge parapets	Maintain and inspect bridge parapets.		DCC OPW	
Maintain and operate defences				DCC	
Lansdowne Road (Newbridge Bridge) to the Lansdowne road Irish Rail bridge					1.5 M
Obtain Part 8 planning for the construction of defences.	Design and construct the defences.	Maintain and operate defences.		DCC OPW	
DS Donnybrook (Phase 2C, 2D & 2E. works between Lansdowne Road Irish Rail bridge and the Smurfit weir)					10 M
Appoint Consultant. Complete Preliminary Designs, and start Part 8 Planning Procedure.	Obtain planning permission. Complete detailed designs. Carry out and complete construction. Maintain existing defences.		Maintain and operate defences.	DCC OPW	
St Enda’s & Tara Hill (Whitechurch)					1.8 M
Procure consultant and design new flood defences. Obtain planning permission for defences		Construct new flood defences, undertake dredging and weir removal	Maintain defences	SDCC, (OPW) (DCC)	
Little Dargle					15 K
Design and construct new flood defences.		Maintain defences		DLRCC	
Smurfit Papers Mills to Shanagarry Apartments					3.23 M
Inspect defences and determine works.		Obtain part 8 planning	Construct defences	DCC (OPW)	
Maintain defences.					

2011	2012-2013	2014-2015	2016+	Who	Estimated Cost
Orwell Gardens					604 K
Design and construct new flood defences.		Maintain defences		DLRCC	

Note: Coastal Flood Protection along Sandymount to be progressed. This coastal protection scheme will also protect Ringsend to Merrion Gates.

Glossary of terms

Analysis Unit (AU) These cover large spatial scale and are large sub-catchments or areas of tidal influence.

Annual Exceedance Probability (AEP) Historically, the likelihood of a flood event was described in terms of its return period. For example, a 1 in 100 year event could be expected to be equalled or exceeded on average once every 100 years. However, there is a tendency for this definition to be misunderstood. There is an expectation that if such an event occurs, it will not be repeated for another 100 years. However, this is not the case; to try to avoid the misunderstanding, flood events are expressed in terms of the chance of them occurring in any year. This can be stated in two ways, namely a percentage or a probability. Taking the above example, we would say that this event has a one per cent, or 1 in 100, chance of being equalled or exceeded in any year.

Appropriate Assessment An assessment of the effects of a plan or project on the Natura 2000 network. The Natura 2000 network comprises Special Protection Areas under the Birds Directive, Special Areas of Conservation under the Habitats Directive and Ramsar sites designated under the Ramsar Convention.

Aquifer A water bearing rock which readily transmits water to wells and springs.

Area of Potential Significant Risk These are existing urban areas with quantifiable flood risk.

Assessment Unit Define the spatial scale at which flood risk management options are assessed. Assessment Units are defined on four spatial scales ranging in size from largest to smallest as follows: catchment scale, Analysis Unit (AU) scale, Areas of Potential Significant Risk (APSR) and Individual Risk Receptors (IRR).

Average Annual Damages (AAD) Depending on its size (or severity), each flood will cause a different amount of flood damage. The average annual damage is the average damage in euros per year that would occur in a designated area from flooding over a very long period of time. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events).

Benefit Cost Ratio (BCR) A benefit cost ratio is the ratio of the benefits of a flood risk management option, expressed in monetary terms, relative to its costs.

Benefits Those positive quantifiable and unquantifiable changes that a plan will produce, including damages avoided.

Biodiversity Word commonly used for biological diversity and defined as assemblage of living organisms from all habitats including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part.

Catchment A surface water catchment is the total area of land that drains into a watercourse.

Digital Terrain Model (DTM) A DTM represents the topography (elevation) of the ground.

Ecological status An expression of the structure and functioning of aquatic ecosystems associated with surface waters. Such waters are classified as being of good ecological status when they meet the requirements of the Water Framework Directive.

Environmental Objective Environmental objectives are broad, overarching principles which should specify a desired direction of environmental change.

Environmental Report (ER) A document required by the SEA Directive as part of a strategic environmental assessment which identifies, describes and evaluates the likely significant effects on the environment of implementing a plan or project.

Estuarine A semi-enclosed coastal body of water with one or more rivers or streams flowing into it, and with an open connection to the sea.

Flood An unusual accumulation of water above the ground caused by high tide, heavy rain, melting snow or rapid runoff from paved areas. In this study a flood is marked on the maps where the model shows a difference between ground level and the modelled water level. There is no depth criterion, so even if the water depth is shown as 1mm, it is designated as flooding.

Flood defence A structure (or system of structures) for the alleviation of flooding from rivers or the sea.

Flood depth maps Illustrate the estimated flood depths for areas inundated by a particular flood event. This provides useful information on potentially dangerous areas of deep flood waters during a flood event.

Flood extent maps Show the estimated area inundated by a flood event of a given AEP event. The flood extents have no depth criterion, so even if the water depth is shown as 1mm, it is designated as flooding.

Flood hazard Refers to the frequency and extent of flooding to a geographic area.

Flood hazard maps Show the harm or danger which may be experienced by people from a flood event of a given annual exceedance probability, calculated as a function of depth and velocity of flood waters.

Flood risk Refers to the potential adverse consequences resulting from a flood hazard. The level of flood risk is the product of the frequency or likelihood of flood events and their consequences (such as loss, damage, harm, distress and disruption).

Flood Risk Management (FRM) The activity of understanding the probability and consequences of flooding, and seeking to modify these factors to reduce flood risk to people, property and the environment. This should take account of other water level management and environmental requirements, and opportunities and constraints. It is not just the application of physical flood defence measures.

Flood Risk Management Measure Structural and non-structural interventions that modify flooding and flood risk either through changing the frequency of flooding, or by changing the extent and consequences of flooding, or by reducing the vulnerability of those exposed to flood risks.

Flood Risk Management Objectives These provide a basis by which the flood risk management options are assessed. Each objective and sub-objective has an indicator, minimum target and aspirational target. Options are scored on how well they perform in meeting the minimum and aspirational targets.

Flood Risk Management Option Can be either a single flood risk management measure in isolation or a combination of more than one measure to manage flood risk.

Flood Risk Management Plan (FRMP) is a large-scale strategic planning framework for the integrated management of flood risks to people and the developed and natural environment in a sustainable manner.

Flood velocity maps Show the speed of the flood water for a particular flood event using graduated colours. The maps provide information on fast flowing flood waters which are potentially dangerous.

Flood Warning To alert people of the danger to life and property within a community.

Floodplain Any area of land over which water flows or is stored during a flood event or would flow but for the presence of flood defences.

Fluvial Pertaining to a watercourse (river, stream or lake).

Geographical Information System (GIS) A GIS is a computer-based system for capturing, storing, checking, integrating, manipulating, analysing and displaying data that are spatially referenced.

Geomorphology The science concerned with understanding the form of the Earth's land surface and the processes by which it is shaped, both at the present day as well as in the past.

Groundwater Water occurring below ground in natural formations (typically rocks, gravels and sands). The subsurface water in the zone of saturation, including water below the water table and water occupying cavities, pores and openings in underlying soils and rocks.

Habitats Directive European Community Directive (92/43/EEC) on the Conservation of Natural Habitats and of Wild Flora and Fauna and the transposing Irish regulations (The European Union (Natural Habitats) Regulations, SI 94/1997 as amended).. It establishes a system to protect certain fauna, flora and habitats deemed to be of European conservation importance.

Heavily modified water body Surface waters that have been substantially changed for such uses as navigation (ports), water storage (reservoirs), flood defence (flood walls) or land drainage (dredging).

High End Future Scenario (HEFS) Represents extreme changes in drivers of flooding, such as climate change and land use change, by 2100.

Hydraulic Computer Model Software tool to solve advanced mathematical equations, based on a variety of parameters, to provide an estimate on water levels, flows and velocities in a watercourse.

Hydrograph A graph showing changes in the discharge (flow) of a river over a period of time

Impermeable Used to describe materials, natural or synthetic, which have the ability to resist the passage of fluid through them.

Individual Risk Receptors (IRR) Essential infrastructure assets such as a motorway or potentially significant environmentally polluting sites.

Inundation To cover with water - especially flood waters.

ISIS 1D/2D hydraulic computer modelling software developed by RPS.

Land Management Various activities relating o the practice of agriculture, forestry, etc.

Land Use Various designations of activities, developments, cropping types, etc, for which land is used.

LiDAR Light Detection and Ranging (LiDAR) is an airborne topographical mapping technique that uses a laser to gather information on the shape and height of the ground.

Material Assets Critical infrastructure essential for the functioning of society such as: electricity generation and distribution, water supply, wastewater treatment, transportation etc.

Mid Range Future Scenario (MRFS) This is a future flood risk management scenario and considers the more likely estimates of changes to the drivers that can influence future flood risk in the Dodder catchment by 2100.

Mitigation measures Measures to avoid/prevent, minimise/reduce, or as fully as possible, offset/compensate for any significant adverse effects on the environment, as a result of implementing a plan or project.

Modelling and Decision Support Framework (MDSF) MDSF is a GIS-based decision support tool developed to assist the CFRAM process through automation of parts of the analysis.

Natura 2000 European network of protected sites which represent areas of the highest value for natural habitats and species of plants and animals which are rare, endangered or vulnerable in the European Community. The Natura 2000 network will include two types of area. Areas may be designated as Special Areas of Conservation (SAC) where they support rare, endangered or vulnerable natural habitats and species of plants or animals (other than birds). Where areas support significant numbers of wild birds and their habitats, they may become Special Protection Areas (SPA). SACs are designated under the Habitats Directive and SPAs are classified under the Birds Directive. Some very important areas may become both SAC and SPA.

Natural Heritage Area An area of national nature conservation importance, designated under the Wildlife Act 1976 (as amended), for the protection of features of high biological or earth heritage value or for its diversity of natural attributes.

Neap tide Occurs when the gravitational forces of the sun and moon act at right angles to each other resulting in a lower than normal tidal range.

Non structural options include flood forecasting and development control to reduce the vulnerability of those currently exposed to flood risks and limit the potential for future flood risks.

Permeable Able to be penetrated by water.

Programme of Measures A list or timetable of intended actions.

Protected Structure A structure that a planning authority considers to be of special interest from an architectural, historical, archaeological, artistic, cultural, scientific, social, or technical point of view.

Ramsar site Wetland site of international importance designated under the Ramsar Convention on Wetlands of International Importance 1971, primarily because of its importance for waterfowl.

Return Period The average interval in years between events of similar or greater magnitude (e.g. a flow with a return period of 1 in 100 years will be equalled or exceeded on average once in every 100 years). However, this does not imply regular occurrence, more correctly the 100 year flood should be expressed as the event that has a 1 per cent probability of being met or exceeded in any one year, expressed as the annual exceedance probability.

Riparian Relating to the strip of land on either side of a watercourse.

River Basin Districts Administrative areas for coordinated water management and are comprised of multiple river basins (or catchments), with cross-border basins (i.e. those covering the territory of more than one Member State) assigned to an international RBD.

Riverine Pertaining to a watercourse (river or stream) and its floodplain.

Runoff That part of rainfall which finds its way into streams, rivers etc and flows eventually to the sea.

Rural Area Watercourses (RAW) are in areas where the flood risk was, at the outset of the Study, considered to be moderate.

Scenario A possible future situation, which can influence either catchment flood processes or flood responses, and therefore how successful flood risk management policies/measures can be. Scenarios are usually made up of a combination of the following: urban development (both in the catchment and river corridor); change in land use and land management practice (including future environmental designations); or climate change.

Scoping the process of deciding the content and level of detail of an SEA, including the key environmental issues, likely significant environmental effects and alternatives which need to be considered, the assessment methods to be employed, and the structure and contents of the Environmental Report.

Screening The determination of whether implementation of a plan or project would be likely to have significant environmental effects on the environment. The process of deciding whether a plan or project requires an SEA.

Special Area for Conservation (SAC), Candidate Special Area for Conservation (cSAC) A SAC are internationally important site, protected for its habitats and non-bird species. It is designated, as required, under the EC Habitats Directive. A cSAC is a candidate site, but is afforded the same status as if it were confirmed.

SEA Directive Directive 2001/42/EC ‘on the assessment of the effects of certain plans and programmes on the environment’.

SEA Statement A statement summarising: how environmental considerations have been integrated into the plan or project; how the ER, the opinions of the public, and designated authorities, and the results of transboundary consultations have been taken into account; and the reasons for choosing the plan or project as adopted in the light of other reasonable alternatives.

Special Area for Conservation (SAC), Candidate Special Area for Conservation (cSAC) A SAC are internationally important site, protected for its habitats and non-bird species. It is designated, as required, under the EC Habitats Directive. A cSAC is a candidate site, but is afforded the same status as if it were confirmed.

Special Protection Area (SPA) A SPA is a site of international importance for breeding, feeding and roosting habitat for bird species. It is designated, as required, under the EC Birds Directive.

Spring tide Occurs when the gravitational forces of the sun and moon reinforce each other resulting in a higher than normal tidal range

Steering Group The Steering Group oversees the production of the FRMP and is expected to comprise key OPW staff together with staff from other local authorities or major stakeholders, where appropriate.

Storm surge Caused by low pressure systems which force the ocean surface to rise higher than the normal sea level.

Structural options involve the application of physical flood defence measures, such as flood walls and embankments, which modify flooding and flood risk either through changing the frequency of flooding, or by changing the extent and consequences of flooding.

Surface Water Water in rivers, estuaries, ponds and lakes.

Sustainability A concept that deals with mankind's impact, through development, on the environment. Sustainable development has been defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland, 1987). Sustainability in the flood risk management context could be defined as the degree to which flood risk management options avoid tying future generations into inflexible or expensive options for flood defence. This usually includes consideration of other defences and likely developments as well as processes within a catchment.

The Office of Public Works (OPW) The lead agency with responsibility for flood risk management in Ireland

Tidal Related to the sea and its tide

Topography Physical features of a geographical area.

Water body A discrete and significant element of surface water such as a river, lake or reservoir, or a distinct volume of groundwater.

Water courses Water features include rivers, lakes, ponds, canals, harbours and coastal waters.

Water Framework Directive (WFD) EU Water Framework Directive 2000/60/EC sets out a system for the integrated and sustainable management of catchments so that the ecological quality of waters is maintained in at least a good state or is restored. The Directive lays down a six-yearly cycle of catchment planning.

List of abbreviations

AA	Appropriate Assessment
AAD	Annual Average Damages
AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
APSR	Areas of Potential Significant Risk
AU	Analysis Unit
BCR	Benefit Cost Ratio
CFRAM	Catchment Flood Risk Assessment and Management
CMRC	Coastal and Marine Resources Centre
DAFF	Department of Agriculture, Fisheries and Food
DCC	Dublin City Council
DEHLG	Department of Environment, Heritage and Local Government
DLRCC	Dun Laoghaire-Rathdown County Council
DTM	Digital Terrain Model
EPA	Environmental Protection Agency
ER	Environmental Report
ERBD	Eastern River Basin District
ESB	Electricity Supply Board
EU	European Union
FFW	Flood Forecasting and Warning
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
GDSDS	Greater Dublin Strategic Drainage Study

GEP	Good Ecological Potential
GES	Good Ecological Status
GDA	Greater Dublin Area
HDA	Habitats Directive Assessment
HEFS	High End Future Scenario
IRR	Individual Risk Receptor
Km	Kilometres
Km^2	Square kilometres
LiDAR	Light Detection And Ranging
m	Metres
m^3	Cubic metres
MCA	Multi Criteria Analysis
MDSF	Modelling Decision Support Framework
mm	Millimetres
MRFS	Mid Range Future Scenario
NDP	National Development Plan
NHA	Natural Heritage Area
NPWS	National Parks and Wildlife Service
OPW	Office of Public Works
SAC	Special Area of Conservation
SDCC	South Dublin County Council
SEA	Strategic Environmental Assessment
SI	Statutory Instrucment
SPA	Special Protection Area

SuDS	Sustainable Urban Drainage Systems
RBD	River Basin District
RBMP	River Basin Management Plan
WFD	Water Framework Directive
Yr	Year

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APPENDIX A

List of Stakeholders

APPENDIX B

List of Objectives, Indicators & Targets

APPENDIX C

Weighting of Objectives and Scoring of Flood Risk

APPENDIX D

Summary of Detailed Option Evaluation

APPENDIX E

Option Description Sheets

APPENDIX F

Monitoring Framework