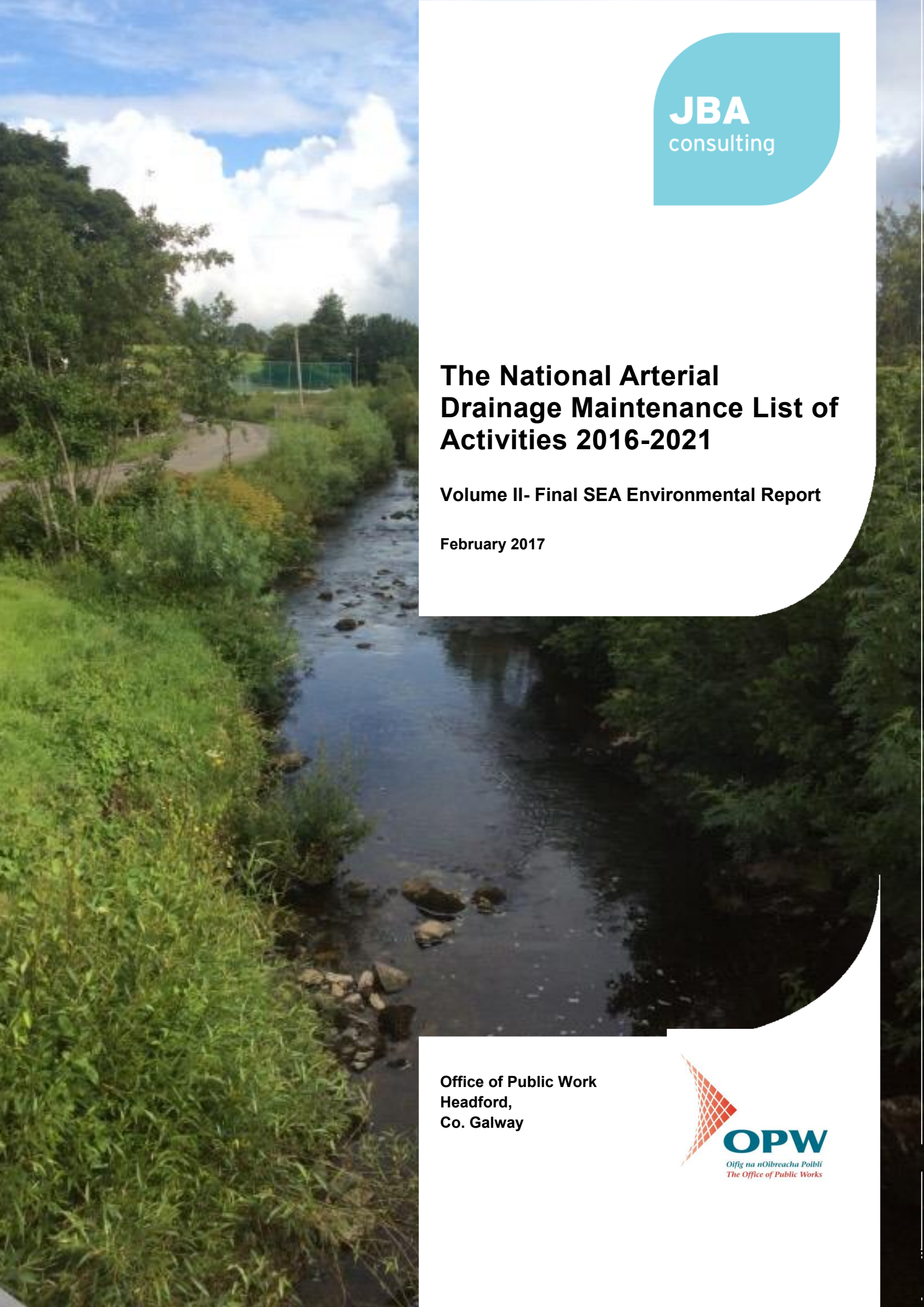

The National Arterial Drainage Maintenance List of Activities 2016-2021

Volume II- Final SEA Environmental Report

February 2017

Office of Public Work
Headford,
Co. Galway

JBA Consulting

24 Grove Island
Corbally
Limerick
Ireland

JBA Project Manager

Tom Sampson BSc MSc FRGS C.WEM MCIWEM

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Version 3.0/ February 2017	Final amendments	Nathy Gilligan, OPW

Contract

This report describes work commissioned by The Office of Public Works, by a letter dated (27/01/2016). The Office of Public Works' representative for the contract was Nathy Gilligan. Tom Sampson, Declan Egan, Anne Murray, Niamh Sweeny and Catalina Herrera of JBA Consulting carried out this work.

Prepared by ..... Catalina Herrera BSc MSc

..... Declan Egan BSc MSc CSci CEnv C.WEM MCIWEM MCIWM

..... Tom Sampson BSc MSc FRGS C.WEM MCIWEM

Reviewed by ..... Declan Egan BSc MSc CSci CEnv C.WEM MCIWEM MCIWM

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List of Acronyms

AA	Appropriate Assessment
ACA	Architectural Conservation Area
CEMP	Construction Environment Management Plan
CFRAM	Catchment-Based Flood Risk Assessment and Management
DAHRRGA	Department of Arts, Heritage, Regional, Rural, and Gaeltact Affairs
DECLG	Department of Environment, Community and Local Government
DHPLG	Department of Housing, Planning and Local Government (Formerly DECLG)
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
EU	European Union
FRMP	Flood Risk Management Plan
GSI	Geological Survey Ireland
IFA	Irish Farmers Association
IFI	Inland Fisheries Ireland
INFF	Irish National Flood Forum
IPCC	Intergovernmental Panel on Climate Change
IROPI	Imperative Reasons of Overriding Public Interest
LAP	Local Area Plan
LULC	Land Use and Land Cover
MCA	Multi-Criteria Analysis
NCCAF	National Climate Change Adaptation Framework
NFM	Natural Flood Management
NHA	Natural Heritage Area
NI	Northern Ireland
NIAH	National Inventory of Architectural Heritage
NMI	National Museum of Ireland
NMS	National Monuments Service
NIG	National Implementation Group
NPWS	National Parks and Wildlife Service
OPW	Office of Public Works
PCD	Public Consultation day
RBD	River Basin District

RBMP	River Basin Management Plan
RPG	Regional Planning Group
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SI	Statutory Instrument
SMR	Sites and Monuments Records
SPA	Special Protection Area
WFD	Water Framework Directive
WMU	Water Management Unit
WTW	Water Treatment Works
WWTW	Waste Water Treatment Works
ZAP	Zones of Archaeological Potential

1 Introduction

The OPW is the authority in Ireland with the statutory responsibility for arterial drainage maintenance and flood relief works. The Arterial Drainage Act ,1945 empowered the OPW to construct and maintain arterial drainage schemes around the country. The current programme is the Arterial Drainage Maintenance Activities (2016-2021). The Flood Relief Schemes maintained by the County Councils are not covered by the OPW Arterial Drainage Maintenance Activities (2016-2021).

In Ireland, and on foot of the 2004 EU Directive, we introduced the requirement of a Strategic Environmental Assessment (SEA) for National Plans and Programmes, for example County Development Plans or Transportation or Energy Programmes. The purpose of the SEA is to carry out a systematic assessment of the Plan or the Programme on the environment before the Plan or Programme is adopted. The Arterial Drainage Maintenance Activities (2016-2021) is subject to a SEA.

This is the Environmental Report for the Strategic Environmental Assessment (SEA) of the National Arterial Drainage Maintenance Activities (2016-2021). This report identifies the significant environmental effects of the proposed maintenance activities on the environment and where significant impacts have been identified, the report outlines appropriate mitigation measures to reduce these potential impacts.

The SEA process for the National Arterial Drainage Maintenance Activities (2016-2021) is being conducted in compliance with national legislation and guidelines to ensure an environmentally sound and transparent assessment.

The Environmental Report was conducted and prepared by JBA Consultants Ltd. Grove Island, Corbally, Co. Limerick. JBA Consultants Ltd. will be referred to hereafter as JBA in this report.

1.1 SEA Definition and Role

Strategic Environmental Assessment is a systematic process for predicting, assessing, and evaluating and mitigating, at the earliest appropriate stage, the environmental effects of a national, regional plan or programme before it is adopted. Its purpose and in accordance with the requirements of the Aarhus Convention, is to give the public and other interested stakeholders an opportunity to participate in the decision making process, and to be kept informed of decisions about a national programme and how they evolved. It will facilitate the integration of stakeholders and public consultation into the environmental decision making at an early stage and allow for the sustainable implementation of environmental management.

In subjecting the National Arterial Drainage Maintenance Activities (2016-2021) to a SEA, appropriate measures for activities and works can be directed to where they are ensuring the sustainability of the environment and also the welfare of humans.

1.2 Legislation and Guidelines

The SEA process is a requirement of European law. The EU enacted the Strategic Environmental Assessment (SEA) Directive under Council Directive 2011/42/EC on the 'Assessment of the Effects of Certain Plans and Programmes on the Environment'. The purpose of the Directive is to undertake an environmental assessment to assess the likely significant impacts of the plan or programme on the environment before it is adopted. The Directive was transposed into Irish legislation under S.I. No. 435 of 2004 - the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations, 2004 and S.I. No. 436 of 2004 the Planning and Development (Strategic Environmental Assessment) Regulations. These statutory instruments were amended under S.I. No. 200 of 2011 and S.I. No. 201 of 2011 respectively.

A number of Irish and European governmental departments have prepared guidance documents to assist SEA practitioners in interpreting the requirements of the SEA Directive and their associated Regulations. The key guidance documents are:

- Department of Environment, Heritage and Local Government 2004: Implementation of SEA Directive: Assessment of the Effects of Certain Plans and Programmes on the Environment. Guidelines for Regional Authorities and Planning Authorities (2004)
- Environmental Protection Agency: SEA Pack (2008)
- Environmental Protection Agency: Consultation Draft of the GISEA Manual (2009).
- European Commission: Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment (2013)
- Developing and Assessing Alternatives in Strategic Environmental Assessment (SEA)
- Integrated Climate Change into Strategic Environmental Assessment in Ireland - A Guidance Note
- SEA Spatial Information Sources - June 2016
- Strategic Environmental Assessment (SEA) and Climate Change: Guidance for Practitioners

1.3 Scope of the SEA

Based on the information presented in the Scoping Report for Arterial Drainage Maintenance Activities (2016-2021) prepared by JBA in May 2016 and the subsequent comments received from the statutory consultees and interested stakeholders, the scope of the SEA of the maintenance activities includes:

- The SEA if for maintenance activities carried out over the next 6 years from 2016 to 2021.
- Assessment of maintenance activities as required under the Arterial Drainage Acts of 1945 and 1995 only. This excludes maintenance activity of drainage schemes and flood relief works carried out under different legislation to the Arterial Drainage Acts 1945 and 1995.
- The Study Area includes the catchments of arterial drainage schemes, embankments and flood relief schemes subject to arterial drainage maintenance activity as set out in Table 3-1. The study area also includes the receiving environment of potential impacts from maintenance activity on these schemes, embankments and flood relief schemes.

1.4 Objectives of the SEA

The objectives of the SEA for the Arterial Drainage Maintenance Activities (2016-2021) are to:

- Determine baseline environmental data
- Identify, predict, and evaluate the impact of the drainage maintenance activities
- Define mitigation measures to alleviate effects
- Allow stakeholder and the public to participate in the development of National Arterial Drainage Activities (2016-2021)

1.5 Layout of the Environmental Report

JBA followed the requirements of the EU Council Directive 2001/42/EC and the Irish Regulations (S.I. No. 200 of 2011) to complete the Environmental Report. The table below (Table 1-1) outlines in summary the contents of the chapters of the report and how each chapter fulfils the requirements of the SEA Directive. A Non-Technical Summary and a Natura Impact Statement accompanies this report.

Table 1-1. Requirement of SEA Directives in SEA Report

Requirement of SEA Directive (Article 5(1) Annex 1)	Section in the Environmental Report
An outline of the contents and main objectives of the plan or programme, or modifications to a plan or programme, and the relationship with other relevant plans or programmes	Section 3 Appendix **Error! Reference source not found.**
The relevant aspect of the current state of the environment and the likely evolution thereof without the implementation	Section 6

of the plan or programme, or modification to the plan or programme	
The environmental characteristics of areas likely to be significantly affected	Section 6
Any existing environmental problems that are relevant to the plan or programme in particular areas of environmental importance such as areas designated pursuant to the Birds Directive and the Habitats Directive	Section 5 Section 6
The environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation	Section 7
The likely significant effects on the environment, including issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors	Section 10
The measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme	Section 11
An outline of the reasons for selecting the alternatives dealt with, and a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information	Section 9
A description of the measures envisaged concerning monitoring in accordance with Article 10	Section 12
A non-technical summary of the information provided under the above headings	Volume I: Non-Technical Summary (NTS)
These effects should include secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative effects.	Section 10

1.6 Habitats Directive Appropriate Assessment

This Environmental Report contains an assessment of the impacts of the National Arterial Drainage Maintenance Activities 2016-2021 on sites of European Conservation importance i.e. Special Areas of Conservation and Special Protection Areas.

The results of the assessment are included in the full Natura Impact Report (NIR) found in Volume III: Arterial Drainage Maintenance Activities 2016-2021 SEA Natura Impact Statement of this report and used to inform the environmental considerations in this SEA.

2 Legislative Background

2.1 Arterial Drainage Legislative Background

Drainage Acts have been passed in this country for the past two centuries in the following years: 1842, 1867,1925,1928, 1945, and 1995.

The Arterial Drainage Act, 1945 was based on the Browne Commission Report (Report of the Drainage Commission 1938-1940), which assessed flooding in Ireland and improvements of land through the use of drainage. The legislation has been operated by the OPW over the last 50 years and it has empowered the OPW to undertake catchment-wide Arterial Drainage Schemes for *"any catchment area for the purpose of preventing or substantially reducing the periodical flooding of land in the area or improving by drainage lands in the said area"* (OPW, 2011). The main focus of the Arterial Drainage Act, 1945 was the improvement of agricultural land.

Following severe flooding in the 1980s and 1990s, the act was amended in 1995 in order to change the focus of flood management towards protection of urban areas with high risk of flooding. This amendment gave the OPW the power to carry out localised flood relief schemes to eliminate the risk of flooding in urban areas.

2.2 Flood Policy

Flood risk in Ireland has historically been addressed through the use of structural or engineered solutions (arterial drainage schemes and / or flood relief schemes). In line with internationally changing perspectives, the Government adopted a new policy[1] in 2004 that shifted the emphasis in addressing flood risk towards:

- A catchment-based context for managing risk,
- More pro-active flood hazard and risk assessment and management, with a view to avoiding or minimising future increases in risk, e.g., from development in floodplains,
- Increased use of non-structural and flood impact mitigation measures.

2.2.1 National Flood Policy

A National Policy Review was initiated by the Minister of State with the responsibility of the OPW. This was introduced to determine flood risk policy and define the roles and responsibility of Departments, local authorities, and relevant organisations. The recommendations of the Report of the Flood Policy Review Group were approved by the Government in September 2004 and these composed the framework of Ireland's flood risk management procedures.

A further development on the management of flood risk in Ireland is the EU 'Floods' Directive[2] [2007/60/EC]. The aim of this Directive was to reduce the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity.

Under the 'Floods' Directive, Ireland, along with all other Member States, are required to undertake a Preliminary Flood Risk Assessment (PFRA) to identify areas of potentially significant flood risk (referred to in Ireland as Areas for Further Assessment, or 'AFAs'), and then for these areas to prepare flood maps in relation to the sources of flood risk deemed to be significant. Ireland is then required to prepare Flood Risk Management Plans (FRMPs) for each unit focussed on managing and reducing the risk within the AFAs. The PFRA, flood maps and the FRMPs need to be reviewed on a 6-yearly cycle.

The OPW is designated as the Competent Authority under SI No. 122 of 2010 for the implementation of the Directive. The following authorities may be designated under SI Nos. 122 of 2010 and S.I. 495 of 2015 as being responsible for the implementation of key requirements of the EU 'Floods' Directive with respect to infrastructure for which they have responsibility:

- All local authorities
- Electricity Supply Board (ESB)

1 Report of the Flood Policy Review Group, OPW, 2004 (www.opw.ie/about/fr_public.htm)

2 Directive on the assessment and management of flood risks, 2007/60/EC

- Waterways Ireland
- Irish Water

2.2.2 Flood Policy Implementation

The National Catchment Flood Risk Assessment and Management (CFRAM) was implemented to address key recommendations from the Flood Policy Review.

The CFRAM programme covers the whole of the country, split into seven large areas called River Basin Districts (RBD). Each RBD is then divided into a number of Units of Management (UoM), where one FRMP will be prepared for each UoM (OPW, 2011).

2.2.3 Drainage and Maintenance

Drainage works have a long history in Ireland stretching back to the mid-19th century. Improvement Schemes were carried out under the 1842 Arterial Drainage Act on localised areas of river catchments. Several hundreds of these minor schemes were carried out with Local Authorities having statutory maintenance responsibility over them. Some of these Schemes have since been included into Arterial Drainage Schemes carried out under the 1945 Arterial Drainage Act.

2.2.4 Arterial Drainage Schemes and Flood Relief Schemes

The Office of Public Works (OPW) is the statutory body through which the government issues responsibility in respect of river drainage and flood relief. It derives its statutory authority from the Arterial Drainage Acts, 1945 and 1995 and the Commissioners of Public Works (Functions and Powers) Act, 1966.

The 1945 Arterial Drainage Act deals with the total river catchment rather than a localised area. Then the Act was further amended in 1995 in response to extensive urban and localised flooding. Following the 1995 Amendment, the OPW began introducing Flood Relief Schemes (FRS). The FRSs are not carried out on a catchment basis, however attention is given to potential downstream effects. The primary purpose of the Schemes was to provide agricultural land from with flood alleviation and outfall for land drainage.

2.2.5 Drainage Districts

There are a large number of isolated rural drainage schemes under the Drainage Acts between 1842 and 1928. These are referred to as Drainage Districts. Some of these drainage districts were included to the catchment Schemes carried out by the OPW, the ones that were not incorporated into Schemes became the responsibility County Councils. Under, Section 30 of the 1945 Act, the statutory duty of maintenance for these schemes rests with the Local Authorities concerned.

2.2.6 OPW's Role and Responsibility in Arterial Drainage Maintenance

Under Section 37 of the Arterial Drainage Act 1945, the OPW is statutorily obliged to maintain all channels, embankment and structureson which it has executed works since the 1945 Act in "proper repair and effective condition" (OPW, 2011).

Maintenance referred to under the Arterial Drainage Act 1945 includes:

1. The maintenance of river channels in a condition that ensures they are free-flowing thus reducing flood risk and providing adequate outfall for land drainage.
2. The maintenance of river and coastal embankments, in a condition that protects benefitting land, to the extent defined in the Scheme, from risk of flooding.
3. The maintenance, repair, and/or replacement of all structures forming part of a Scheme, including accommodation bridges, weirs, sluice barrages, sluices, pumping stations, grids, sand traps and tidal flap gates.

Failure to comply with these obligations would be contrary to the Arterial Drainage Act and could lead to a "writ of mandamus" or an award of compensation arising from claims for damage to the benefiting lands. All of the completed Arterial Drainage and Estuarine Embankment Schemes are now maintained under the statutory obligation (OPW, 2011).

It is important to note, that maintenance activities are required because the original drainage works has resulted in unstable catchment sediment regimes, where upstream sediment load has increased as drained land is used for agriculture and increased in-channel sediment deposition through widening and deepening river channels. Over time, the channels will experience increased deposition and nutrient input resulting in deficiency of the overall scheme due to changes in the conditions of the channels and the risk that drained channels will revert to their pre-drainage condition.

3 Programme Description

3.1 Introduction

Where the commissioner of the OPW has completed a drainage scheme under the Arterial Drainage Act, 1945 and 1995, it becomes the statutory requirement of the OPW to maintain the drainage works forming part of the Scheme.

The annual drainage maintenance programmes are compiled for each scheme to maintain the drainage network or flood relief scheme structures. Every year approximately one-fifth of all the watercourses are maintained, which are prioritised based on the potential flood risk posed to the surrounding areas

The draft National Arterial Drainage Activities (2016-2021) are included in full in Volume IV: Appendix **Error! Reference source not found.** of this document. The remainder of this section will summarise the key points of the programme.

3.2 Arterial Drainage Maintenance

3.2.1 The Arterial Drainage Schemes

The OPW is the authority which has the statutory responsibility for river drainage and flood relief works. The scope of the Arterial Drainage Maintenance Activities (2016-2021) includes all the schemes listed in Table 3-1 and displayed in Figure 3-1. The Flood Relief Schemes maintained by other Local Authorities are not subject to the OPW Arterial Drainage Maintenance Activities (2016-2021).

Table 3-1. OPW Schemes carried out under the Arterial Drainage Acts 1945 and 1995

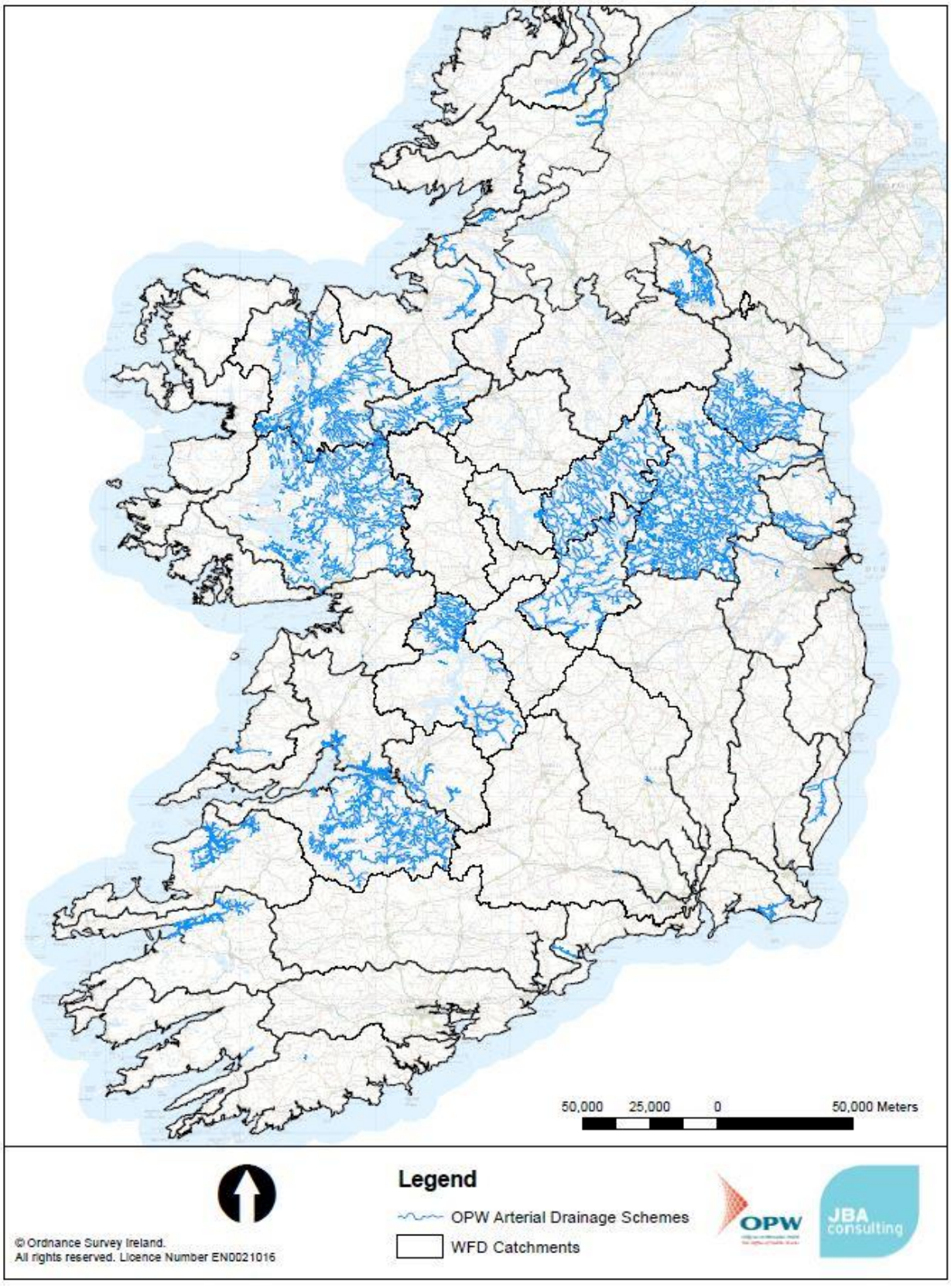
Scheme	Duration of Works	Areas Benefiting (hectares)
Major Schemes (River Catchments over 100,000 acres in extent)		
Brosna	1948-1955	34883
Glyde & Dee	1950-1957	10643
Feale	1951-1959	10724
Corrib-Clare	1951-1959	10724
Maine	1954-1964	30310
Inny	1959-1963	4694
Deel	1962-1968	20234
Moy	1960-1971	4816
Corrib-Headford	1967-1973	24685
Boyne	1969-1986	48157
Maigue	1973-1986	12343
Corrib-Mask	1979-1986	9712
Boyle	1982-1992	10845
Blackwater (Monaghan)	1984-1992	2367
Minor Schemes (River Catchment 25,000-1000,000 acres)		
Nenagh	1955-1960	2630
Ballyteige/Kilmore	1959-1961	931
Broadmeadow& Ward	1961-1964	2995
Killimor/Cappagh	1962-1968	5099
Bonet	1982-1992	1295
Other Small Schemes (River Catchment less than 25,000 acres)		
Clareen	1959-1961	445
Ouvane	1962-1963	162
Matt	1964-1965	202
Duff	1963-1965	1457
Brickey	1965-1967	405
Abbey	1964-1967	364
Knockcroghery	1967-1968	202
Creegh	1968-1969	405
Burnfoot/Skeoge	1968-1970	162
Kilcoo	1969-1971	162
Owenavorragh	1968-1970	1052

Scheme	Duration of Works	Areas Benefiting (hectares)
Carrigahorig	1968-1971	1538
Groody	1970-1973	1214
Deel and Swillyburn	1957-1961	1416
Cloonburn	1967-1968	162
Estuarine Embankment Schemes		
Shannon (Limerick)	1962-1971	4897
Shannon (Clare)	1958-1960	728
Fergus	1959-1960	728
Owenogarney	1955-1959	850
Swilly etc	1961-1968	1295
Flood Relief Schemes		**Year Completed**
Belclare, Clare River maintained as part of the Corrib-Headford Drainage Scheme		1995
Gort Town, Co. Galway maintained as part of the Gort Flood Relief Scheme		1997
Sixmilebridge, Co.Clare maintained as part of the Owengarney Catchment Drainage Scheme		1997
Lacken (Ardraham), Co. Galway maintained as part of the Lacken Drainage Scheme.		1997
Nanny River, Duleek, Co. Meath maintained as part of the Nanny Scheme.		1998
Mulkear River, Newport, Co. Tipperary maintained as part of the Mulkear River Scheme		1998
Ballymakeogh, Co. Tipperary maintained as part of the Scheme		1998
Mulkear River, Cappaghmore, Co. Limerick maintained as part of the Scheme		2000
Bridge End, Co. Donegal, improvement to the Skeoge Scheme and is mantained as part of the Scheme.		2000
Bandon River, Dunmanway, Co. Cork, this is maintained as part of the Scheme.		2001
Shinkeen Stream, Hazelhatch, Co. Kildare, this is maintained as part of the Scheme.		2001
Maam Valley, Co. Galway; this was an improvement to the Scheme, and is maintained as part of the Scheme.		2001
Suir River, Carrick-on-Suir, Co. Tipperary; this is maintained as part of the Scheme.		2003
Nore River, Kilkenny; This is maintained as part of the Scheme		2006
Ennis, Co. Clare, maintained by the OPW but the maintenance of the pumps is through SLA with the County Council.		2013
Mornington, Co. Meath, maintained as part of the Mornington Scheme		2012
Tullamore, Co. Offaly, this is maintained as part of the Scheme.		2013
Clonmel, Co. Tipperary maintained by the OPW, however maintenance pumps is through SLA and the County Councils.		2014
Fermoy, Co. Cork maintained by the OPW, however maintenance pumps is through SLA and the County Councils.		2015
Mallow, Co. Cork maintained by the OPW, however maintenance pumps is through SLA and the County Councils.		2016

Table 3-2: Flood Relief Schemes not maintained by the OPW as part of the Arterial Drainage Maintenance Activities 2016-2021

Flood Relief Scheme	Maintained by	Year Completed
Dromcollogher, Co. Limerick	County Councils	2000
Morrell River, Maynooth, Co. Kildare	County Council	2003
Leixlip, Co. Kildare	County Council	2009
Ennis, Co. Clare	Channel and embankments by OPW, pumps by County Council through service level agreement.	2013
Carlow, Co. Carlow	County Council	2013
Johnstown, Co. Meath	County Council	2012
Clonmel, Co. Tipperary	Channel and embankments by OPW, pumps by County Council through service level agreement.	2014
Fermoy, Co. Cork	Channel and embankments by OPW, pumps by County Council through service level agreement.	2015
Mallow, Co. Cork	Channel and embankments by OPW, pumps by County Council through service level agreement.	2016

Figure 3-1. Arterial Drainage Channels/Embankments/Flood Relief Schemes maintained by the OPW



3.2.2 List of Activities

The National Arterial Drainage Maintenance 2016-2021 activities include:

- Channel Maintenance Activities
- Embankment Maintenance Activities
- Structural Maintenance Activities
- Flood Relief Scheme Maintenance Activities

The OPW is responsible for the maintenance of 11,500 km of channel, 730 km of embankments, some 18,500 bridges and 750 ancillary structures such a sluice gates and pumping stations.

The majority of Arterial Drainage Maintenance works is on channel maintenance with an average channel requiring maintenance every four to six years. Some channels may require annual maintenance and others only require maintenance once every twenty years.

Channel Maintenance 2016-2021

Channel Maintenance is required on average every four to six years. Channels with prolific vegetation growth may require maintenance every year, while channels with self-cleaning characteristics may only need maintenance every 20years. The activities involve the following:

- Removal of water-entrained silt and associated vegetation from the bed of the channel by hydraulic excavators
- Bank protection work involving-profiling the bank in-situ or importing protection material such as rock armour or log poles in case of channel breaches due to erosion.
- Trimming or removal of trees or branches that may be impinging on channel.
- Aquatic Vegetation Cutting: For wide channels weed-cutting boats are used.

When developing the annual maintenance programmes, consideration is given to impacts on fisheries and Natura 2000 Sites, through the consultation of an ecological consultant and consultation with Inland Fisheries Ireland and National Parks and Wildlife Services.

Embankment Activities 2016-2021

A programme of embankment strengthening was introduced to reverse the damage which resulted from limited monitoring and increased deteriorating conditions of embankments. The programming of works consists of inspections of sections of embankments known to be at high risk. Repair works consist of topping up clay embankments to design height and structural strengthening by importing rock/soil material or utilising in-situ material. The works are carried out by direct labour or contract.

Structural Maintenance Activities 2016-2021

Around 18,500 bridges provide farmers with farm vehicular or foot access across Arterial Drainage Scheme Channels. Inspections are carried out to assess necessity of repair or replacement of structures. Approximately 170 bridges are repaired/replaced annually. Other structures such as gates, barrages, and pumping stations are also maintained or repaired.

Flood Relief Scheme Maintenance Activities 2016-2021

All Flood Relief Schemes have a statutory maintenance requirement. The need for maintenance is identified at a regional level on an annual basis. Activities vary depending on the characterisation of the Scheme, durable structural works may require minimum maintenance, and however other schemes may require continued maintenance. Activities may vary, and include:

- Periodical silt removal
- Riparian vegetation management
- Maintenance of designed channel capacity

Maintenance Access Corridors (MAC)

The OPW is statutory required to maintain all Arterial Drainage Schemes in `proper repair and effective condition` to reduce to flood risk. The Maintenance Access Corridor (MAC) to allow for

drainage maintenance operations is provided along each channel on both riverbanks. However, the MAC to allow for drainage maintenance is generally only maintained from one side of the channel and this allows for periodic access to the channel for maintenance. Some channels require an MAC on both banks.

Programme Exclusion

The National Arterial Drainage Maintenance Activities 2016-2021 activities does not include maintenance of the following:

- Newly (i.e. still in construction or planning stage) constructed Arterial Drainage Schemes
- Catchment Flood Risk Assessment & Management Study proposals or recommendations (CFRAM)
- New Flood Relief Schemes, which entail public exhibition and Ministerial Approval.
- Drainage Districts that are the responsibility of Local Authorities.

3.3 Environmental Management and Maintenance Planning

All maintenance operations are carried out in accordance with OPWs Environmental Management Protocols and Standard Operating Procedures (SOP).

The maintenance function of the OPW is divided into three regions for the purpose of programming and executing the work. The East Region main office is in Newtown, Trim, Co. Meath with four sub-offices in Ardee, Monaghan, Mullingar and Wexford. The South West region main office is in Templemungret, Co. Limerick with two sub-offices in Listowel and Portumna. The West region main office is in Headford, Co. Galway with two sub-offices in Ballina and Lifford.

Every year, each Arterial Drainage Maintenance Region produces a draft Annual Drainage Maintenance Programme for the upcoming year. The proposed works are indicated for each channel under the headings A-F:

A-Silt and vegetation management
B-Aquatic Vegetation Cutting
C-Bank Protection
D-Bush Cutting Branch Trimming
E- Tree Cutting
F- Bridge/ Structure Repairs

The OPW Environmental Section reviews the draft programme for the upcoming years including timing, season, month, and duration of the works. Maintenance activity is planned for the appropriate season depending on legislation and the species and habitats present.

The frequency of maintenance is usually driven by a 5-year cycle or specific landowner requests. Prior to maintenance activity, the site foreman and machine operators walk the reach to be maintained and review health and safety aspects and the 10 - point Environmental Drainage Maintenance (EDM) Guidelines (see below, Section 3.4). The operators and foremen are provided with maps and details of the information in the OPWs drainage maintenance species and habitats layers. It is the decision of the driver how to undertake the maintenance using established maintenance access corridors or whether further access to the watercourse or embankments are required.

Communication with stakeholders

The draft Regional Arterial Drainage Maintenance Programmes are forwarded to the Inland Fisheries Ireland (IFI) Environmental River Enhancement Programme (EREP) project manager who reviews the programme for appropriate sites and study locations for EREP projects.

The Arterial Drainage Maintenance Region forwards the relevant sections of its final Annual Drainage Maintenance Programme for the upcoming year with a copy of appropriate scheme maps, to the National Parks and Wildlife Services (NPWS) Regional Managers and the IFI Directors.

Consultation should also include National Monument Service (NMS) at the Department of Arts, Heritage, Regional, Rural, and Gaeltacht Affairs (DAHRRGA)

The Arterial Drainage Maintenance Regions offer the opportunity for a meeting with stakeholders to discuss the Annual Drainage Maintenance Programme.

Environmental River Enhancement Programme (EREP)

Sites identified for river enhancement projects will be subject to hydromorphological surveys to ensure the enhancements are technically feasible, along with other screening processes (i.e. Water Framework Directive Programme of Measures under the requirements for morphology). Some sites will be prioritised on the basis of best return for investment. In all cases, Inland Fisheries Ireland (IFI) is the statutory authority to give design guidance to the OPW. Angling Clubs or other sectoral funding source can liaise with IFI authorities in respect to the design and environmental monitoring requirements. EREP schemes are also subject to the Habitats Directive Appropriate Assessment process.

As part of EREP projects, team members are required to carry out walkover surveys as an opportunity to discuss in detail on site the potential options for river enhancement. In attendance are members of IFI and OPW. The table and figure below display EREP Schemes per catchment.

Figure 3-2. EREP Schemes per catchment

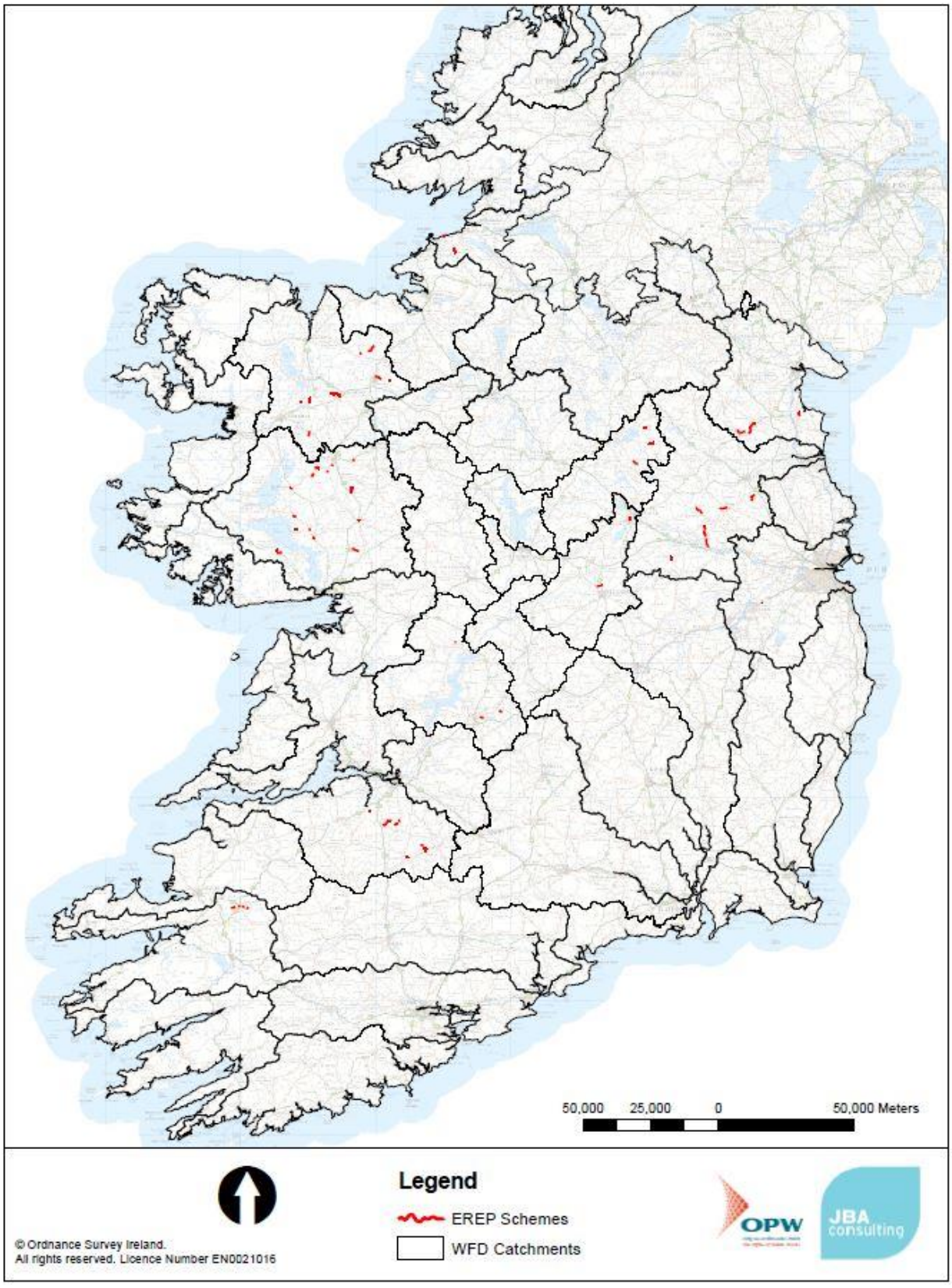


Table 3-3. EREP Capital Projects Completed by Catchment

Catchment	OPW Schemes	No. of EREP Projects
Lough Neagh & Lower Bann	Monaghan Blackwater	1
Newry, Fane, Glyde and Dee	Glyde and Dee	3
Boyne	Boyne	6
Liffey and Dublin Bay	Ryewater and Hazelhatch (Shinkeen), Leixlip (Kildare)	1
Laune-Maine-Dingle Bay	Maine	4
Shannon Estuary South	Deel, Maigue, Shannon Embankment South, Maigue outfall	8
Lower Shannon (A)	Brosna	1
Lower Shannon (C)	Clareen, Nenagh, Woodford, Killmor and Carrigahorig	4
Upper Shannon (F)	Inny	3
Corrib	Corrib	16
Moy and Killala Bay	Moy	9
Erne	Abbey, Duff and Kilcoo	2

Appropriate Assessment Process

Arterial Drainage Maintenance Activities Schemes are subject to Appropriate Assessment process during the planning stages of the five-year drainage maintenance programme and other specific works such as EREP schemes and emergency repairs to embankments. The OPW issues relevant completed Screening for Appropriate Assessment and Natura Impact Statements directly to the NPWS District Conservation officer and to the Development Applications Unit (DAU), Department of Arts, Heritage, Regional, Rural, and Gaeltact Affairs (DAHRRGA).

Management staff are responsible for implementing all prescribed mitigating measures and ensuring that operational staff are made aware of all relevant site specific mitigating measures that have been outlined in the reports along with any comments from the DAU.

National Recording Process

Record Cards are used by the operators and management staff to record information on the presence of Lamprey, Crayfish, Kingfishers, Mussels, Otter, and other site specific environmental information. When recorded these cards are sent to the Environmental Section of the OPW. All of the information is recorded into a national database. Each drainage office is responsible to fill out the Weekly Record Cards. Once input is reviewed and approved, the database is accessible to all offices. Any additional information in relation to a particular species such as mitigating agreements for a particular channel, or individual observations (i.e. protected species present) will be included in the database.

3.4 OPW Standard Operating Procedures (SOP)

There is a total of seven SOPs that are applied during the operational works (See Volume IV: Appendix **Error! Reference source not found.** and http://www.opw.ie/en/floodriskmanagement/operations/environmentalactivities/).

- Environmental Drainage Guidance Notes (10 steps to Environmentally Friendly Maintenance)
- Lamprey SOP
- Crayfish SOP
- Otter SOP
- Mussel SOP
- Invasive Species SOP
- Zebra Mussel SOP

Environmental Drainage Maintenance (EDM) Guidelines

Operational crews are audited annually for implementation of the EDM guidelines and environmental operating procedures (SOPs). The auditing is carried out separately by both IFI and OPW Environment Section on a rotational basis to ensure all operational crews are audited at least once every three years. These can be found online here: http://www.opw.ie/en/floodriskmanagement/operations/environmentalactivities/.

The OPW and IFI, summarised the Environmental Strategies for Channel Maintenance into the following 10 steps:

1. Protecting bank slope
2. Confining works to channel centre
3. Spoil Management
4. Vegetation Management
5. Skipping sections
6. Tree Management
7. Berm Management
8. Replacing stone and boulders back in the channel
9. Gravel bed channels
10. New excavations in the channel

There are also additional mitigation measures recommended for different stages of maintenance works. These include skipping sections of the channel in order to retain intact habitat, avoidance of secondary disturbance downstream, proposal of longer periods between maintenance, timing maintenance to accommodate spawning or breeding seasons, among others.

Some examples of the Environmental Drainage Maintenance Guidelines contained in the current version of OPW's SOPs are outlined below.

Salmonids

Maintenance of the channel must be in accordance with Salmon and Trout Spawning Season. The location of the works must accommodate spawning areas. Activities on spawning beds are carried out from July to September. Prior to works, the local IFI must be consulted. River enhancement works to improve fisheries and broader ecology are covered under the EREP programme.

Lamprey

The presence of Lamprey must be checked against the OPW GIS database before any in-channel work takes place. If Lamprey are encountered, several members of staff should be notified (Foreman, Engineer) and the location and abundance of Lamprey should be noted in a **Weekly Record Card**. In order to reduce potential impacts three approaches are suggested such as skip a defined stretch of channel, confine maintenance to 2/3 of the channel in order to retain marginal vegetation and silt intact, and maximise the use of weed cutting buckets.

Crayfish

The presence of Crayfish must be checked against the OPW GIS database before any in-channel work takes place. If Crayfish are encountered, several members of staff should be notified (Foreman, Engineer) and the location and abundance of Crayfish should be noted in a Weekly Record Card. In order to reduce potential impacts, three approaches are suggested: skip a defined stretch of channel, confine maintenance to 2/3 of the channel in order to retain marginal vegetation and silt intact, and maximise the use of weed cutting buckets.

Otter

Otters are widespread across all sizes of drainage channels nationally. Operational staff should walkover the site one week before the maintenance commences. Dense areas with access directly to water should be noted and avoided where feasible. Any recognisable signs of otter presence observed such as spraints, footprints, or suspected Holts will be recorded on the Weekly Record Cards. There should also be no maintenance activities within a 50m buffer each side of an otter holt.j

Freshwater Pearl Mussel (FPM)

According to NPWS, there are 91 known FPM populations in Ireland, nine of which are OPW channels (See Section 6.7). There are no in-stream works allowed in an area recognised as a FPM habitat, typically only non in-stream works adjacent to the channel are permissible under OPW's working procedures. Simple activities require special precaution in order to minimise channel bed disturbance. The need for silt management procedures must be assessed for works upstream of the FPM habitat before their commencement.

Kingfisher

In areas known to hold populations of Kingfishers, the mitigation measures include avoiding nesting areas, and visual sighting of kingfisher must be recorded on Weekly Report Cards. All sightings must be recorded on the Record Database in accordance with the National Recording Process.

Birds

The removal of any abnormally dense layer of vegetation is to be executed between September and February to minimise impacts on nesting birds. If the channel is located within a Natura 2000 site containing valuable over-wintering bird populations, consultation with the NPWS must be undertaken to determine the timing and phasing of the works to limit disturbance.

Bats

In the case that the removal of a large tree is necessary for the maintenance works, regard is given to the likelihood of bat roosting habitat, and these trees are left in their fallen position for 24hrs to allow any bats to vacate. For structural works the works are assessed for their impacts on bats and a bat specialist is contracted to survey for bat presence before the works commence, to avoid entombment of any bats.

Invasive Species

Multiple invasive species are spread nationally and it can be assumed that one or more of these are present on any work sites. The most common species of invasive plants include Japanese Knotweed, Giant Hogweed, and Himalayan Balsam. The OPW does not have any direct responsibility for the management of invasive species. However, in order to ensure OPW operations are not a vector for these invasive, measures are required to reduce the risk of spreading. The OPW SOPs for invasive species are found in Volume IV: Appendix **Error! Reference source not found.**

Zebra M Musssels are present in various locations around Ireland such as the River Shannon, Grand Canal, L Derg, L.Ree, L Garra, L. Derravaragh, L.Sheelin, L.Corrib, L.Conn, L.Arrow, the River Glyde catchment, among others (See Section Introduction6.7.1). Due to the quick spread of the species, any proposed work close to a river or lake that has potential to contain Zebra Mussels must be flagged and staff should pay special attention to cleaning procedures for all equipment, prior to removal from site.

Wetlands - Bogs, Fenlands and Turloghs

All channels located within an SAC must be checked against the list of channels that impinge on Raised Bogs, Fen habitats, Turloughs and have regard to any NPWS agreements. In the case where impact is likely, it is necessary to conduct a site visit in consultation with NPWS to determine mitigation measures, such as: skipping channel in questions, while recognising the drainage and flood risk management requirements, maximising use of weed bucket, and inspection by OPW line management to determine the likelihood of over-digging the channel below the original design datum.

Tree Management

Site with dense tree cover may require maintenance for conveyance or fisheries purposes. Removal of dense layers or vegetation can only be executed between September and February, to minimise disturbance on nesting birds. IFI requests to reduce "tunnelling" on drainage channels. In order to facilitate IFI's request, OPW management staff and IFI officer carry out a site visit, where they propose a selective approach to tree removal, which maintains a dappling of shade along the channel.

3.5 Mitigation and Monitoring

3.5.1 Environmental Management System

All of the maintenance works carried out as part of this programme are done with OPWs Environmental Management Protocols and SOPs. There are various approaches taken by the OPW to promote environmental management such as the introduction of EREP and the provision of ongoing environmental training to staff. The most recent formal environmental training took place in 2010 and focused on the most recent environmental practices. In addition, in 2008, the operational staff received a training course in Otter Awareness.

Geographic Information Systems (GIS) are a significant tool to manage both existing and future environmental data, which allows for a rapid and accurate transfer of geographical environmental information.

The Arterial Drainage Programme is screened for potential impacts on Natura 2000 sites. If channels are identified as having the potential to impact on a Natura 2000 site, it is subject to Appropriate Assessment under Article 6(3) of the Habitats Directive. A national framework has been set up where Arterial Drainage Maintenance activities undergo an Appropriate Assessment for a 5-year period. Each scheme undergoes an AA and all prescribed mitigation measures are disclosed in the plan.

The ecological consultant carries out walkover surveys for pre and post maintenance works for a representative number of sites. The completed assessment is issued to NPWS and the Department of Arts, Heritage, Regional, Rural, and Gaeltact Affairs (DAHRRGA).

An Ecological Impact Assessment (EcIA) is needed if the works are not within the Natural 2000 site but if they still have influence over the broader protected habitat.

3.5.2 Monitoring Programme

The monitoring of Arterial Drainage Maintenance Activities is made-up of two components:

- On-site implementation of OPWs Environmental Management Protocols and Standard Operating Procedures.
- Scientific monitoring programme carried out under EREP, assessing impacts of routine maintenance and capital enhancement projects on the river corridor biodiversity.

The OPW in coordination with Inland Fisheries Ireland (IFI) has an ongoing research programme to assess the impacts of Arterial Drainage Maintenance Activities and the Environmental River Enhancement Programme (EREP) on the river corridor biodiversity and hydromorphology. In addition, a Series of Ecological Impact Assessments (EcIA) on Arterial Drainage Maintenance has been published of the effects of drainage maintenance activities on various ecological

receptors including otter, Atlantic salmon, raised bogs, etc. The scope of the monitoring is limited to EREP schemes as shown in Figure 3-2.

3.5.3 Auditing

Auditing (both internal and external) of all maintenance activity is carried out in compliance with Environmental Management Protocols and SOPs. These audits are carried out by IFI to assess the extent by which the Environmental Drainage Maintenance (EDM) Guidance Notes are followed by all maintenance activities (including EREP). These external audits cover approximately one-third of the OPW drainage machine crew annually. A rating system was developed by the OPW and monitored by IFI and OPW to identify any particular issues, with particular machine crews.

All audit results are forwarded to the relevant engineer for that drainage scheme within two working weeks. In the event of an audit showing non-compliance with EDM guidelines and SOPs, the relevant engineer is notified within one working day.

3.5.4 Scientific monitoring

The EREP biological monitoring programme assesses the impacts of routine maintenance and capital enhancement projects on the ecology of the river corridor. Flora and fauna (fish, birds, macro-invertebrates, lamprey, and crayfish) are monitored across various sites. The physical changes of the channels are also monitored. The monitoring programme is reviewed periodically and altered as required.

Physical monitoring includes pre and post works monitoring of a number of variables such as bank-full width, wetted perimeter width, channel length, depth, velocity, and canopy cover.

The report itemises the following activities as proposed in the OPW's National Arterial Drainage Maintenance Draft List of Activities (2016-2021) (Volume IV: Appendix **Error! Reference source not found.**).

- EREP has included monitoring of hydromorphological conditions in its programme.
- The River Hydromorphology Assessment Technique (RHAT) monitoring system has been approved as the appropriate method to determine hydromorphological status.
- Floral monitoring: Aquatic (in-channel), marginal vegetation, and riparian vegetation. A walkover survey comprised of a species inventory, as well as, tree survey.
- Macro-invertebrate monitoring: Sampling is carried out at both experimental and control sites, where species inventories are compiled.
- Fish sampling: The primary focus of EREP fish stock survey is salmon and sea trout, however, data from all species encountered during survey are recorded.
- Bird population studies: Key objective of bird surveys are to record abundance, species richness, and distribution of bird species in OPW channels and assess the impact of drainage on bird species.
- Lamprey and fish studies: OPW funded studies carried out by Central Fisheries Board to examine effects of Arterial Drainage Maintenance Activities on lamprey and white-clawed cray fish. Ecological Impact Assessment (EcIA) were carried out for both species which recommended further studies. The surveys include monitoring population size and age structure, prior to and in a series of years post maintenance.

3.5.5 Data Recording

The OPW takes a proactive approach to the national recording of environmentally sensitive species on Arterial Drainage Maintenance scheme channels. Locations of species including crayfish, lamprey, kingfisher and Freshwater Pearl Mussel are recorded on the Weekly Records Cards by OPW Industrial staff. The datasets are reviewed periodically and once approved, the datasets are available at all OPW Regional offices

Records are stored in GIS spatial datasets and are currently available to all drainage maintenance staff through maps and will be made available through the OPW Drainage Maintenance application immediately. Increased environmental performance has led to the development of a broader spectrum of GIS datasets to include the current national

environmental topics. These datasets will also be uploaded onto the OPW Drainage Maintenance app in due course and will include the following:

- Invasive species
- Other environmental sensitivities
- Habitat mapping
- Habitat photos
- Bridge photos

4 Approach to the Strategic Environmental Assessment (SEA)

4.1 Introduction to the SEA Process

The SEA is an integral part of the development of any large-scale plan, programme, or strategy. The legislative requirements for a SEA are discussed in Section 1.2.

The overall aim of the SEA Directive is to:

'provide for 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.'

The SEA process is a formal, systematic method which is used to consider the likely effects of implementing a plan or programme on the environment before a decision is made to adopt it. It also ensures environmental considerations are addressed as early as possible and are in balance with technical and economic factors. The process also requires the delivery of multiple objectives and stakeholder inclusion. In summary the proposed National Arterial Drainage Maintenance Activities (2016-2021) will be assessed against a number of Environmental Objectives to determine if the programme supports or conflicts these objectives. A monitoring programme will be initiated when the Arterial Drainage Maintenance Activities (2016-2021) are adapted by the OPW.

The SEA that was prepared by JBA is environmentally objective and sustainability led and where conflict is identified JBA suggests mitigation measures. The environmental monitoring programme is designed to identify, at an early stage, the success or otherwise of the suggested mitigation measures.

4.1.1 SEA Process

In the context of preparing stages for the National Arterial Drainage Maintenance Activities (2016-2021), six main stages were implemented as described below. We are currently at stage three of the process - Assessment and Evaluation (Environmental Report).

- **Screening**: to determine the requirement for a SEA for the National Arterial Drainage Maintenance Activities (2016-2021).
- **Scoping**: to liaise with the Statutory Consultees to identify key issues of concern that should be addressed in the Environmental Report
- **Assessment and Evaluation**: the identification, prediction, evaluation of the impacts of the National Arterial Drainage Maintenance Activities (2016-2021) on the environment. Where significant impacts are identified suitable mitigation measures to remedy the impacts will be suggested.
- **Consultations**: Consultations with the Statutory Bodies, Stakeholders and the public on the National Arterial Drainage Maintenance Activities (2016-2021) and the proposed recommendations and mitigation measures.
- **Revisions and Amendments to the Environmental Report**: Based on the comments received, they may influence the programme and consequently the Environmental Report.
- **Post Adoption**: Preparation of the SEA Statement and subsequent monitoring of the Programme during its implementation.

4.2 Screening

In 2015, the OPW in discussion with the EPA determined that the SEA process should be applied to the Arterial Drainage Maintenance Activities (2016-2021). Screening is the process used to determine the requirements for a SEA. The EPA screened in the SEA for the Arterial Drainage Maintenance Activities (2011-2015), therefore the SEA process related to the next six-year cycle of the National Arterial Drainage Maintenance Activities for 2016-2021.

4.3 Scoping

A Scoping Report was prepared in May 2016 and was sent to the listed Statutory Consultees as defined in the SEA Regulations. The Scoping Report prepared by JBA is available at http://www.opw.ie/en/floodriskmanagement/operations/environmentalactivities/arterialdrainagemaintenancesea2016-2021/ and in summary provided a description of the baseline environment for the National Arterial Drainage Maintenance Activities (2016-2021). The Scoping Report considered the following environmental aspects:

- Human Beings
- Land-use
- Soil and Geology
- Flora, Fauna, and Biodiversity
- Water
- Cultural Heritage
- Landscape
- Infrastructure and Material Assets
- Air and Climate Change

The Scoping Report established a decision-making framework based on a number of Environmental Objectives that were used to assess the impacts of the Arterial Drainage Maintenance Activities (2016-2021) on the environment. The Environmental Objectives were refined and a number of sub-objectives, targets and indicators were developed for the objectives.

The purpose of the Scoping Report was to allow the statutory consultees and other stakeholders to make comments/suggestions on the approach in the preparation of the Environmental Report. A number of the consultees and the stakeholders replied to our invite to comment. Their comments and suggestions are further discussed in Chapter 8 and JBA has identified where their comments/suggestions have been considered in the preparation of the Environmental Report. Volume IV: Appendix A of this report provides details on how the submissions were addressed in the preparation of the Environmental Report.

4.4 Assessment & Evaluation

The assessment stage of the SEA requires an evaluation of the impacts of the Arterial Drainage Maintenance Activities (2016-2021) on the environment. Schedule 2 B of the SEA Regulations requires details on the current state of the environment. A desk-top baseline assessment of all environmental aspects was conducted by JBA as part of the Scoping Report. This information has been updated for this report and is presented in Chapter 7.

Data gaps relating to site specific data on sensitive receptors in the Study Area is identified as one of the short comings of the SEA process. To combat this JBA has taken the 'precautionary approach' to the assessment of the potential effects of the activities. The assessment is based on the current information that was available at the time of the study. The strategic assessment undertaken here in this report will be complimented by more site specific assessments that will be undertaken as part of the maintenance activities. Further environmental assessment will be carried out at a detailed level for the individual maintenance activities.

4.4.1 Catchment-wide assessment

A catchment-wide assessment has been undertaken for each WFD hydrometric area (i.e. catchment or group of smaller catchments draining to the sea) in response to EPA comments on the SEA Scoping Report. The assessment groups arterial drainage schemes within the catchment together for the assessment. Baseline environmental information in relation to land use, water and ecology has been summarised in Section 6.

4.4.2 Strategic Environmental Objectives

An initial set of Environmental Objectives and Targets were established as part of the Scoping exercise. This list was circulated to the Statutory Consultees and Stakeholders. The finalised

Environmental Objectives and Targets were agreed with the OPW. Furthermore, the targets and indicators were assessed to determine if they were measurable and would they provide sufficient robust evidence in the future to determine the success or otherwise of the SEA for the National Arterial Drainage Maintenance Activities (2016-2021). In summary the Environmental Objectives and Targets established for this SEA are based on European, and National Policies and Programmes. The Maintenance Activities are undertaken at a strategic level and the subsequent impact assessment of these activates are against these high level European and National Policies. This approach undertaken by JBA allows for a qualitative assessment of the impacts of the activities. A more detailed, quantitative assessment of the impacts of the activities on different catchments will be carried out as part of the OPW pre and post-maintenance activities. This approach meets the requirements of the SEA Regulations.

4.4.3 Significance Testing

In line with the SEA Regulations, the following criteria has been used to describe the significance of an impact. In identifying the changes to the baseline and describing the magnitude and duration of the impacts, JBA has used the following criteria to assist in our assessment:

- The significance of the impact whether the impacts are positive or negative i.e. does the National Arterial Drainage Maintenance Activities (2016-2021) support or conflict with the Environmental Objectives.
- The duration of the impact i.e. will the impacts occur during the maintenance activities only or will the impacts manifest themselves during the operation of the maintained arterial drainage scheme, embankments or flood relief scheme?
- What will be the geographical extent of the impact i.e. will it be local, regional or national?
- Whether the impacts are direct or indirect, secondary or cumulative.

4.4.3.1 Significance

The overall significance of the impact of an option on the environmental objectives is dependent upon two factors: the size of the disturbance caused (magnitude) and the sensitivity of the receptor. The sensitivity of the receptor may be based on a legal designation of a site, for example a Special Area of Conservation or a Natural Heritage Area. It may also be based on the proximity to sensitive receptors such as schools, hospitals etc. In our assessment we have assigned different ratings for positive and negative impacts. Within these two groups we have further defined the impacts as major, moderate and minor. This refined impact assessment has allowed more specific mitigation measures to be suggested during the maintenance activities.

The significance testing, at this strategic level is qualitative and is based on the baseline information and technical judgement. More quantitative significance testing will arise during the pre and post maintenance activities.

Activities that posed a significant **major negative impact** on a receptor would or has the potential to have a permanent, irreversible impact on the baseline conditions. In other cases, the maintenance activities would or could have a negative impact on a designated European site, an area of archaeological importance, or a negative impact on humans close to the site.

Maintenance activities that were assessed to have a **moderate negative impact** on a receptor would or could have a temporary, short term reversible impact on a receptor. This level of impact is most likely to arise during the maintenance activity.

Maintenance activities that were assessed to have a **minor negative impact** on a receptor would or could have a short term negative impact on a local habitat or receptor. It is anticipated that this impact would be remedied by good maintenance practices and would only be of short duration ie. less than a day or two.

A **neutral impact** would arise where there is likely to be a change in the baseline conditions but where the level of change/impact is negligible.

Activities displaying a **major positive impact** will have a positive effect on the baseline conditions and will support the environmental objectives.

A **moderate positive impact** will have a moderate positive impact on the baseline conditions and will partially achieve the requirements and support the environmental objective and sub-objective.

Maintenance activities displaying a **minor positive impact** will exceed the sub-objective only.

4.4.3.2 Duration of the Impact

It is anticipated that the majority of the impacts on the environment will occur during the maintenance activity. However, some impacts may arise over time for example hydromorphological impacts on a riverbed due to the presence of a culvert or in-river flood defences. The duration of effects used in this SEA reflects the guidance given by the EPA in their 2015, Draft Guidelines on Information to be Contained in an Environmental Impact Statement (refer to Table 4-1).

Table 4-1. Duration of effect

Effect	Duration of the Effect
Temporary effect	Lasting less than 1 year
Short-term effect	Lasting 1 to 7 years
Medium term effect	Lasting 7 to 15 years
Long-term effect	Lasting 15-60 years
Permanent effect	> 60 years

4.4.3.3 Extent of the Impacts

The extent of the impact of the proposed options are described in the table below (Table 4-2). It should be noted that these impacts are assessed at a strategic level and predicted impacts are only.

Table 4-2. Extent of Impact

Impact	Extent of Impact
Local (L)	Sub-catchment
Regional (R)	Catchment
National (N)	River Basin

Where a significant impact was identified during the assessment mitigation measures to remedy same were identified. Opportunities (positive impacts that could achieve the aspirational targets) were identified also.

4.4.4 Mitigation Measures

Where the assessment has identified significant environmental impacts, mitigation measures will be required to reduce/remedy these impacts. The mitigation measures that are considered as part of this assessment are generic and more site specific mitigation measures, such as revised/updated SOPs will be required. JBA can only recommend that these mitigation measures are considered and that for the purposes of this assessment we are assuming that they will be installed. The need for the installation of on-site specific mitigation measures will be a requirement upon completion of a pre-maintenance assessment. JBA has made a number of recommendations which should be considered for the on-going maintenance activities. These recommendations are discussed at length in Section 11.

In addition, JBA has carried out a desk top assessment for the catchments to identify the presence of designated sites, and designated species. This information can be used by the OPW to identify possible environmental constraints before undertaking maintenance. This would form part of the pre-maintenance activity as discussed in Section 11.2.1.

4.4.5 Residual Impacts

Residual impacts can be defined as impacts that remain after the installation of the mitigation measures. For the purposes of the SEA it is difficult to accurately assess potential residual impacts and it is considered that this is better addressed at the project environmental impact assessment stage.

4.4.6 Presentation of Assessment Results

As required in Annex II (2) of the SEA Directive (2001/42/EC) and S.I No. 435 of 2004 (as amended by S.I. No. 200 of 2011), *'the probability, duration, frequency and reversibility' of the effects should be described. This is further extended to 'the cumulative nature of the effects' and 'the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected'*.

The results of our assessment are presented in Section 9 of the Environmental Report. The information in the tables reflect the requirements of the Directive (and Regulations) as listed above.

4.4.7 Confidence Levels

It is recognised that there are some data gaps in relation to some baseline information. However, our assessment fulfils the requirements of the strategic assessment as required by the Regulations. Site specific baseline data will be gathered for the planning and environmental assessment. Our assessment outlines where pre- maintenance ecological surveys are necessary and we have also highlighted where statutory consents are required.

4.5 Monitoring

A monitoring programme allows the actual impacts of the Programme to be tested against those that were predicted. It allows issues of concern to be identified and dealt with in a timely manner, and environmental baseline information to be gathered for future Programme reviews. Monitoring is carried out by reporting on the set of indicators and targets drawn up previously and used to describe the future trends in the baseline, which will enable future positive and negative impacts on the environment to be measured.

The OPW will be responsible for implementing the monitoring programme.

The recommended monitoring programmes will encompass the National Arterial Drainage Maintenance Activities (2016-2021) and will likely be implement at various stages of the programme. It would be practical to combine the monitoring of maintenance activity with the CFRAM programme monitoring and the Water Framework Directive where possible.

5 Interaction with other Plans, Programmes, and Policies

5.1 Introduction

In addition to gathering data on the existing environmental baseline, a key part of the SEA process is to determine the plan and policy context in which the National Arterial Drainage Maintenance Activities will be implemented. The proposed National Arterial Drainage Maintenance Activities will influence, and will in turn be influenced by, a number of external statutory and non-statutory plans, strategies and policies and ongoing studies. The interaction of the environmental management objectives within these documents, with the proposals of the proposed activities, must therefore be considered. It is necessary to consider these interactions at all levels of the plan and policy-making hierarchy; European, National, Regional and Local.

This chapter, and supporting Volume IV: Appendix B, provides an overview of the plans, policies and programmes influencing the National Arterial Drainage Maintenance Activities. Any identified actions from this study will also need to comply with relevant international and national legislation such as the Water Framework Directive and the Habitats and Birds Directives; these requirements will be expressed in the environmental objectives developed (see Section 6).

5.2 Plan and Policy Context

As part of the SEA process, the relationship of the National Arterial Drainage Maintenance Activities operations with regard to other plans and programmes have been considered and reviewed for this study. Table 5-1 the legislation, policies, and plans/programmes adopted at the European Union (EU), National or Regional level, which could influence the National Arterial Drainage Maintenance Activities, further details are provided in Volume IV: Appendix B.

Spatial plans are a key plan type for consideration during the process as an understanding of the potential future land-use changes, over the short to medium term, will be based on published statutory and non-statutory spatial planning documents. An understanding of this is also important to enable future revisions of these plans to positively address issues identified in the National Arterial Drainage Maintenance Activities which provides opportunity to inform future development proposals.

Table 5-1. Legislation, policies, and plans/programmes adopted at the European Union, National or Regional level

Level	Plans, Policies and Programmes Reviewed
International	EU Drinking Water Directives
	EU Common Agricultural Policy
	EU Strategic Environmental Assessment (SEA)
	Bathing Water Directive (2006/7/EC)
	EU Bird Directive (2009/147/EC)
	EU Biodiversity Action Plan – Halting the loss of Biodiversity by 2010.
	The Habitats Directive (Council Directive 92/43/EEC)
	EU Water Framework Directive
	The Clean Air for Europe (CAFÉ) Directive
	EU Flood's Directive 2007 - Directive 2007/60/EC on the assessment and management of flood risks, 2007
	The Fourth Daughter Directive (2004/107/EC)
	EU Regulation 1143/2014 on Invasive Alien Species
	EU Directive on Environmental Impact Assessment (1989/227) EU Directive on Environmental Impact Assessment 2014/52/EU
Transboundary	CFRAM Draft Flood Risk Management Plans
	Draft 2cd-Cycle River Basin Management plants
National Legislation	Arterial Drainage Act 1945 and Amendment Act 1995 Acts empowering the OPW to implement and maintain Arterial Drainage Schemes (1945) and Flood Relief Schemes (1995)
	Coastal Protection Act, 1963
	S.I. No. 122 and S.I. No. 495 of 2010 and 2015 Transposing Instruments for the EU 'Floods Directive -European Communities (Assessment and Management of Flood Risk

Level	Plans, Policies and Programmes Reviewed
	S.I. No. 465 and S.I. No. 201 of 2004 and 2014 Transposing instruments for the EU Strategic Environmental Assessment Directive -European Communities (Environmental Assessment of Certain Plans and Programmes) (Amendment) Regulations 2004 & 2011
	S.I. No. 477 of 2011 Transposing Instruments for the EU Habitats Directive -European Communities (Birds and Natural Habitats) Regulations 2011
	Planning and Development Act, 2000 (S.I. No.30 of 2000) and associated regulations Principal Planning Act (and Amendments) -Planning and Development regulations 2001 to 2015
	Climate Action and Low Carbon Development Act 2015
	S.4 6 [No. 2.] [2012.] Water Services (Amendment) Act 2012
	Waste Water Discharge (Authorisation) Regulations, 2007 (S.I. No. 684 of 2007)
	Architectural Heritage (National Heritage) and Historic Monuments (Miscellaneous Provisions) Act 1999
	National Monuments Acts 1930-2004 amendments
National Policy /Plans	National Peatlands Strategy 2015 (DAHG)
	National Planning Framework (under preparation)
	National Spatial Strategy (NSS) 2002 – 2020
	National Development Plan 2007 – 2013: Transforming Ireland
	Strategy for Renewable Energy: 2012 – 2020
	A Framework for Sustainable Development for Ireland (Public Consultation Draft, 2011)
	Actions for Biodiversity 2011-2016. Ireland's 2nd National Biodiversity Plan
	Ireland National Climate Change Strategy 2007 - 2012
	Ireland Rural Development Programme 2007-2013
	Rural Environmental Protection Scheme (REPS)
	GRID25: A Strategy for the Development of Ireland's Electricity Grid for a Sustainable and Competitive Future
	FoodWise 2025: A vision for Irish Agri-food and fisheries
	Tourism Product Development Strategy, 2007 – 2013
	National (Climate) Mitigation Plan (In preparation /SEA underway)
	Sectoral Climate Adaptation Plans (In preparation)
	National Species Action Plans (SAPs) (for relevant species)
	Draft Plan for Forestry and Freshwater Pearl Mussel in Ireland
	SAC Raised Bog Conservation Management Plan (SAC Blanket Bog Conservation Management Plan also to commence preparation).
	National Report for Ireland on Eel Stock Recovery Plan (2008)
	National Heritage Plan (2002)
	Conserving Ireland's Maritime Heritage, 2006
	OPW Minor Flood Mitigation Works Programme
	Second Nitrates Action Programme 2010-2013
	National Renewable Energy Action Plan to 2020
	Delivering a Sustainable Energy Future for Ireland
	The National Bioenergy Action Plan
	The National Energy Efficiency Action Plan
	Smarter Travel - A Sustainable Transport Future.
	The Forest, products, and people, Ireland Forest Policy Review
	Ireland Prioritised Action Framework (PAF) for Natura 2000
	Food Wise 2025 and the associated Implementation Plan (DAFM)
	National Rural Development Programme 2014-2020 (DAFM)
	National Climate Change Mitigation Plan
	2015 Climate Action and Low Carbon Development Act
	National Strategic Aquaculture Plan (DAFM)
	National Forestry Programme (DAFM)
	National Forest Policy Review (DAFM)
	Capital Investment Programme (Irish Water)
	Water Services Strategic Plan
	National Wastewater Sludge Management Plan
	Waste Water Sludge Management Plan (Irish Water)
	Offshore Renewable Energy Development Plan (DCENR) (Onshore infrastructure)

Level	Plans, Policies and Programmes Reviewed
	Draft BioEnergy Plan (DCENR)
	The NRA Design Manual for Roads and Bridges (DMRB)
	The NRA Manual of Contract Documents for Road Works (MCDRW)
	Code of Practice: various semi-state bodies have enacted COP specifically for Archaeology, including: Coillte, NRA, Railway Procurement, Iarnrod Éireann; Bord na Mona; Irish Concrete Federation; ESB Networks; EirGrid; Bord Gais Éireann.
Regional/Sub-Regional	The National Forestry Programme 2014-2020
	Regional Waste Management Plan
	Regional Economic and Spatial Strategies (to commence)
	Draft Regional Planning Guidelines for the West Region 2010 – 2022
	The Border Regional Authority: Draft Regional Planning Guidelines (2010-2022)
	Mid-West Regional Planning Guidelines 2010 – 2022
	WFD River Basin Management Planning (Second cycle underway)
	Groundwater Protection Schemes
	Loughs Agency
	Draft Transport Strategy for the Greater Dublin Area 2015-2035 (NTA)
	Dublin Water Supply Project (DCC)
	Strategic Infrastructure Development Proposals
	Draft Transport Strategy for the Greater Dublin Area 2015-2035 (NTA)
	Dublin Water Supply Project (DCC)
	National CFRAM Programme, Flood Risk Management Plans (FRMP)
	Dublin Port Master Plan 2012-2040 (Dublin Port Company)
	Dun Laoghaire Harbour Company Master Plan
	Fisheries Management Plan (IFI)
	Coillte District Strategic Plans
	Sub-regional study for Galway Transportation and Planning (2002)
Local	Environmental River Enhancement Programme
	County Development Plans
	Local Area Plans
	Master Plans and SDZ Plans
	County Biodiversity Action Plans
	Freshwater Pearl Mussel Sub-Basin Management Plans
	Shellfish Water Action Programmes
	County Heritage Plans and Local Heritage Plans
	County Wind and Renewable Energy Strategies

5.2.1 River Basin Management Plan

River Basin Management Plans (RBMP) take an integrated approach to the protection, improvement, and sustainable management of the water environment. The planning process revolves around a six -year planning cycle of action and review, to produce a revised RBMP.

The 1st RBMP was prepared for eight River Basin Districts (RBDs). The first cycle was valid for a six-year period from 2009-2014. The plans summarised the waterbodies that were at risk of not achieving good status. The plans describe the results and recommends potential measures that could help the watercourses meet WFD objectives. An overview of the status of all waterbodies are presented in compliance with the requirements of the WFD.

The second cycle of River Basin Management Plans:2015-2021 are in preparation and due to be published between December 2016-June 2017, as stated in the EPA website. The districts will be changed. For the 2nd Cycle, the Eastern, South Eastern, South Western, Western and Shannon River Basin Districts will be merged to form one national River Basin District. In relation to the North Western and Neagh Bann International River Basin Districts a single administrative area will be established in the Republic of Ireland portion of these two RBDs for the purpose of coordinating their management with authorities in Northern Ireland.

5.2.2 The National Catchment Flood Risk Assessment (CFRAM) Programme

The National CFRAM Programme commenced in 2011 to deliver the core components of the National Flood Policy, adopted in 2004, and on the requirements of the EU 'Floods' Directive (Refer to Section 2.2.2 Flood Policy Implementation for more detail). The Irish CFRAM programme is being carried out in parallel with other similar programs across the EU. The CFRAM Programme comprises of three phases:

1. The Preliminary Flood Risk Assessment (PFRA) :2011.
2. The CFRAM Studies and parallel activities: 2011-2015,
3. Implementation and Review: 2016 onwards.

5.2.3 Forestry Management

Currently, forest cover in Ireland is 10.7% making it the least wooded country in Europe, along with the Netherlands. The average forest cover in Europe is 37% (DAFMa, 2014).

There are various national policies relevant in the context of Forest Management in the Republic of Ireland:

- The National Forestry Programme 2014-2020
- The Forest, products, and people, Ireland Forest Policy Review
- Coillte's Business Management Units (BMU) Strategic Plans and Forest Management Plans
- DAFM's, Statement of Strategy 2011-2014
- Food Harvest 2020 and Food Wise 2025
- Ireland Prioritised Action Framework (PAF) for Natura 2000

These policies and plans are in accordance with the following European Union (EU) guidelines and regulations:

- European Union Guidelines on State aid for agriculture and forestry and in rural areas 2014 to 2020 addressing in particular the Common Assessment Principles.
- Regulations (EU) No. 1305/2013 of the European Parliament and of the council on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulations (EC) no 1698/2005.

All plans have a common focus on the conservation and preservation of forests, improved biodiversity, and increased number of broadleaved forests. These plans hope to increase Ireland's forest cover by following sustainable forest management principles which promotes environmentally sound, socially beneficial and economically viable practices. These plans and programs demonstrate that there are interactions between land cover, land use and management, drainage maintenance and flood risk. Natural Flood Management (NFM) approaches consider hydrological processes across a whole catchment of a river to determine measures that can be used as means of flood management using natural processes. An example is the presence of forestry in upland areas can minimise the extent and the duration of flood experienced downstream. The ability of the woodland soils to quickly absorb and store rain water is a well-known fact. Interception of rainfall by their canopies can significantly reduce the amount of rain fall that falls on the ground. They also, by their presence hold back and delay the passage of rain water to rivers and streams. The NFM approach is an example of a current evolving best practice approach.

5.2.4 Coillte BAU Strategic Plans 2016-2020

Coillte's Business Area Unit (BAU) cover all of Ireland. The purpose of a BAU strategic plan is to set out plans for the forest and non-forest business that will take place in the BAU during the plan period. Coillte's aim is to develop its forests in a way that is environmentally sustainable, socially sustainable and economically sustainable.

5.2.5 The Climate Action and Low Carbon Development Act, 2015

This recently introduced act places legal obligations on all Government Departments and semi-state bodies to consider climate change effects and the need for greenhouse gas mitigation measures. The Act forms part of the development of the National Mitigation Plan and the National Adaptation Framework.

5.2.6 Draft Climate Change Sectoral Adoption Planned Flood Risk Management (2012-2019)

The Flood Risk Management Climate Change Adaptation Plan has been prepared under the remit of the National Climate Change Adaptation Framework. It sets out the policy on climate change adaptation of the OPW. The scope of the plan includes:

- A review of the existing science relating to the potential impacts of climate change on flooding.
- An outline of the potential increase in flood hazard and flood risk due to climate change.
- An overview of current areas of work in the flood risk management sector.
- A policy and actions for climate change adaptation to be pursued and applied by the OPW and other responsible Departments/Agencies in the development of flood risk management strategies and measures.
- There was no specific mention of the OPW sectoral plan of the adaptive capacity of Arterial Drainage Schemes and Embankments.

5.3 Related studies

There are number of studies that are ongoing and have the potential to influence and be influenced by the Arterial Drainage Maintenance Activities (2016-2021). These are detailed below:

- Catchment-based Flood Risk Assessment and Management (CFRAM) studies (refer to Section 2.2).
- Inland Fisheries Ireland (IFI) ongoing studies
- Environmental River Enhancement Programmes (EREP's)
- Food Harvest 2020- A Vision for Irish Agri-Food and Fisheries
- Food Wise 2025
- REstoring river FOR effective catchment Management (REFORM)
- HYDROFOR: Assessment of the impacts of forest operation on the ecological quality of water.
- Integrated Catchment Management (https://www.catchments.ie/)
- Hydro-morphology standards review

5.3.1 Environmental River Enhancement Programmes (EREP)

The Office of Public Works (OPW) funds EREP Capital projects that are co-ordinated and managed by Inland Fisheries Ireland (IFI). The programme aims at enhancing drained salmonid rivers. Although the drainage works reduced the flooding in various areas benefitting agriculture, there were some negative impacts on fisheries, angling, and on river corridors. EREP commenced in 2008 and it involved two different approaches: capital enhancement and enhanced maintenance. These projects are carried out in a small subset of rivers within the arterial drainage river network and they focus primarily on salmonid habitats. The EREP has represented a good starting point to introduce the concept of river restoration to Ireland and address the ecological impacts of physical modification.

5.3.2 Food Harvest 2020

This is a strategy for the medium-term development of the agri-food (including drinks) fisheries and forestry sector for the period to 2020. It outlines the key actions needed to ensure that the sector contributes to the maximum possible extent to our export-led economic recovery and the full development of the smart economy. The targets for 2020 included increase of value added (40%), exports (42%), and primary production (33%). By 2015 the goal was to increase primary

output by €700m, increase value-added by €1bn, achieve export target of €10bn, increase annual aquaculture by 10,000 Metric Tonnes, and increase value by €100m (DAFF, 2011).

5.3.3 Food Wise 2025

Food Wise 2025 is the report produced by the 2025 Agri Food Strategy Committee, led by the Department of Agricultural, Food, and the Marine. It sets out a cohesive, strategic plan for the development of agri-food sector over the next decade. The Committee has identified that opportunities will arise because of significant population growth and greater access to international markets. In addition, the Committee recognises that the increased pressure on global agricultural resources and the environment will offer potential further growth opportunity for the Irish agri-food and fisheries sector. While Food Harvest 2020 contained a number of detailed sectoral targets, Food Wise 2025 contain just four headline aspirations:

- Increase the value of agri-food exports by 85% (19 billion euros)
- Increase value added to the sector by 70% (13 billion euros)
- Increase the value of primary production by 65% (to 10 billion euros)
- Achieving these targets is expected to deliver a further 23,000 jobs in the Agri-food sector by 2025.

5.3.4 REstoring river FOR effective catchment Management (REFORM)

REstoring river FOR effective catchment Management (REFORM), a four-year integrated research project, grouping 26 partners from 15 countries, that addresses challenges to reach the ecological objective for rivers as required by the EU Water Framework Directive. The ecological impacts of hydromorphological modifications are poorly understood and the extent to which theses impacts can be reversed lacked scientific evidence. REFORM's goal was to refine current practices and tools, as well as, improve procedures for assessing pressures, impacts, and mitigation measures with more precision and sensitivity than previously done.

The EPA Catchment Science and Management Unit is developing a fluvial geomorphological assessment tool for Irish rivers and catchments to address hydromorphological component of WFD waterbody characterisation. The proposed method will be based upon the Italian Morphological Quality Index (MQI) method, developed as part of the REFORM programme. The MQI takes a fluvial geomorphological based approach as it considers processes (e.g. sediment production, water/sediment/wood flux, river channel adjustment), along with the features that these processes create. It is a multi-scale assessment where the 'reach' scale is the basic spatial unit (1-10km). This method is composed of two sections, segmentation (to identify morphological typologies to understand how a river will behave in a certain stretch of river) and condition assessment. The results of this assessment has the potential of benefiting the National Arterial Drainage Maintenance Activities (2016-2021) in the future.

The REFORM programme has also developed tools and guidance in relation to all aspects of hydromohpology and river restoration. The programme deliverables include guidance and case studies on how to assess, justify, design, implement and monitor river restoration projects.

5.3.5 Assessment of the Impacts of Forest Operations on the Ecological Quality of Water (HYDROFOR)

The HYDROFOR Project was a 7-year project (2008-2014 inclusive) funded by the EPA, the Department of Agriculture, Food, and the Marine (DAFM) in partnership with researchers from the National University of Ireland, Galway (NUIG), University College Dublin (UCD), and University College Cork (UCC), assessed the relationship between conifer forests and forestry operations, and surface water quality and ecology in Irish river and lakes. The research was undertaken to build on existing knowledge base from research projects on forests and address specific knowledge gaps that inform the further development of the Water Framework Directive (WFD Directive 2000/60/EC) Programmes of Measures (POMs) relevant forest operations.

5.3.6 STRIVE Report: Interactions of Soil Hydrology, Land-Use and Climate Change and their impact on Soil Quality (SoilH)

The research program focused on the study of the risk posed to Irish soils, in the face of changes in land use, land management and possible shifts in climate. They assessed the key functions of soils and interactions of soil hydrology, land use, and climate change. They concluded that there was very little evidence of widespread erosion or widespread compaction of the Irish soils. The authors recommended that the EPA address rainfall extremes with consequent threats of flooding as a potential threat of soil.

5.3.7 Integrated Catchment Management (catchment.ie)

An EPA led portal for integrated catchment management from the EPA WFD perspective which provides resources, data, and maps available to the public. The website is educational and encourages public participation in catchment management.

5.3.8 Hydromorphology Standards Review

Revision of the current hydromorphology standards by the European Committee for Standardisation (CEN) is due to commence by the end of 2016. The relevant standards to be reviewed are listed below and could potentially impact upon the WFD designation and classification of Arterial Drainage Scheme catchments, channels and embankments.

- EN14614:2004 Water Quality - Guidance standard for assessing the hydro-morphological features of rivers
- EN15843:2010 Water Quality - Guidance standard for determining the degree of modification of river hydromorphology

6 Current Environmental Status

6.1 Introduction

The following section outlines the environmental baseline, in line with the SEA Directive. The purpose of this part of the Environmental Report is to identify the current environmental quality baseline for a number of environmental aspects. Based on baseline data and predicted trends, either positive or negative, JBA has established a number of measurable Environmental Objectives against which the maintenance activities can be assessed. We have developed suitable indicators to measure the trends in the Environmental Objectives in the future. The purpose of the indicators is that they are measurable and trends can be identified easily. The current trends of each receptor and interactions with the Arterial Drainage Maintenance Activities is discussed.

The following sections will address the current environmental status in relations to:

- Section 6.2- Human Beings
- Section 6.3- Water
- Section 6.4- Morphology, geomorphology, and hydromorphology
- Section 6.5- Geology and soils
- Section 6.6- Land-use and Land-cover
- Section 6.7- Flora and Fauna
- Section 6.8- Cultural Heritage
- Section 6.9- Climate Change

Each section evaluated the baseline for a variety of environmental aspects and contains the following information:

- Introduction to the topic(s) to be discussed
- Existing environment within the study area for that environmental aspects
- Potential threats
- Possible Opportunities

In accordance with the SEA Regulations (S.I. 435 of 2004), considerations have been given to whether the environmental effects, both positive and negative, of the Arterial Drainage Maintenance Activities are likely to be significant on each receptor.

6.1.1 Data Sources

The information necessary to identify existing condition in the study area has been gathered from:

- Desktop studies of existing and historical information;
- Consultations and review of the Scoping Report with statutory bodies such as National Parks and Wildlife Services (NPWS), Environmental Protection Agency (EPA), Department of Arts, Heritage, Regional, Rural, and Gaeltacht Affairs (DAHRRGA), Inland Fisheries Ireland (IFI) among other organisations.
- NPWS data on designated sites
- EPA Envision, data, and resources online
- Geological survey of Ireland (GSI) dataset
- EPA State of the Environment 2016 Report "Ireland's Environment An Assessment 2016"
- NPWS Article 17 and Article 12 reports "The Status of EU Protected Habitats and Species in Ireland 2013" and " Ireland's Summary Report for the period 2008 – 2012 under Article 12 of the Birds Directive"

Summary tables were put together to highlight environmental receptors across all the catchments in the Republic of Ireland. These receptors are grouped into three areas: ecology, water, and land cover/ land use.

The summary tables were assembled by using data from:

- The EPA's Catchment database (www.catchments.ie)
- The National Biodiversity Data Centre (NBDC)
- CORINE land use/land cover 2012 dataset
- EPA data and resources online

6.2 Human Beings

6.2.1 Introduction

The Republic of Ireland population estimate, based on the CSO statistical release on August 2015, is 4,635,400. The general trends witnessed between the 2006 and 2011 Irish census were (Table 6-1):

- Decrease in immigration and increase in emigration,
- Slight increment in the rate of natural increase (the subtraction of crude birth rate and crude death rate),
- Overall population growth from 4.2 million (2006) to 4.5 million (2011).

The 2014 and 2015 (CSO year ending estimates) show a less significant variation in population change with (Table 6-1):

- Increase in immigration
- Slight decrease in emigration and natural increase

Statistics show that since 2011, the overall population has increased approximately 1-2% annually (Table 6-1; CSO, 2012).

Table 6-1.CSO Statistical Release: August 2015 (Source: CSO, 2015)

	Census		Year Ending	
	2006	**2011**	**April 2014**	**April 2015**
Immigration	107,800	53,300	60,600	69,300
Emigration	36,000	80,600	81,900	80,900
Net Migration	71,800	-27,300	-21,400	-11,600
Of which Irish Nationals			-29,200	-23,200
Natural Increase	34,200	47,500	37,900	37,400
Population Change	106,000	20,100	16,500	25,800
Population	**4,239,848**	**4,588,252**	**4,609,600**	**4,635,400**

Housing and Development

The Regional Planning guidelines (and Regional Economic and Spatial Strategy) once prepared within the lifetime of the Plan, will set out updated/reviewed population targets up and identify key areas for growth and development which may need to be supported by arterial drainage activities.

In comparison with the rest of Europe, the population of Ireland continues to be relatively sparse, with approximately 60 persons per square kilometre as opposed to the EU's average of 116 persons per square kilometre (Eurostat, 2011). In more recent years, the Irish population has become more urbanised, especially around major cities.

The Arterial Drainage Maintenance Activities (2016-2021) aims to contribute to viable and sustainable communities through its contribution to flood risk management and land drainage. The activities related to drainage and flood relief schemes are intended to preserve or maintain the level of flood risk to existing property, agricultural land and material assets. For arterially drained channels, the maintenance activities preserve the function of the Arterial Drainage Scheme to enable productive land use. Maintenance of structures ensures continued access to land and road networks. Arterial Drainage Scheme channels, in general, do not provide flood

protection against larger floods and so maintenance to the channels only influences on more frequent and less severe flooding. Maintenance activity, however may impact upon the flood response elsewhere in the catchment.

New developments and housing units should not be developed in floodplains or areas of high flood risk, especially if located in low-lying zones. The Irish Government recognises the threat of climate change and Local Authorities are required to implement measures, particularly in Development Plans and Strategic Development Polices, to adapt to climate change. Current Development plans contain several policies and objectives dealing with climate change. Current housing shortages will create pressure for rapid development and precautions (i.e. flood risk assessments) should be taken.

Workforce

Employment and industry in Ireland is constantly changing due to economic variations. The broad industry groups in the labour force in the 2006 and 2011 census are listed below (Table 6-2). The major industry groups based on a comparison of the census year are health and social work; education; wholesale and retail trade; and real estate, renting, and business activities. An industry that evidently has not recovered from the recession is construction, whose numbers remain less than half of those in 2006. The Arterial Drainage Maintenance Activities (2016-2021) could contribute to local and rural employment by helping maintain access to local services and transport networks as well as maintain the productivity of agriculture and forestry land and in placed also is to protect these assets from frequent less severe flooding and providing land drainage. Programmes that work in conjunction with the Arterial Drainage Maintenance Activities (2016-2021) include the EREP (Environmental River Enhancement Program), which aims to enhance fisheries, benefiting the fishing, recreation, and tourism industry.

Table 6-2. Population ages over 15 years and over in the labour force (number) by Province, broad industrial group, and Census year (2011). (Source: CSO, 2014).

Employment	2006	2011
Agriculture, forestry and fishing	89,277	**94,247**
Mining, quarrying and turf production	7,751	5,674
Manufacturing industries	243,182	**193,080**
Electricity, gas and water supply	11,290	13,116
Construction	215,184	90,357
Wholesale and retail trade	257,309	**265,751**
Hotels and restaurants	100,731	**103,560**
Transport, storage and communications	105,705	97,569
Banking and financial services	85,413	93,151
Real estate, renting and business activities	180,973	**184,251**
Public administration and defence	101,264	113,521
Education	127,476	**163,728**
Health and Social Work	191,219	**203,379**
Other community, social and personal service activities	80,358	84,665
Industry not stated	132,910	101,311
Total at work	**1,930,042**	**1,807,360**
Unemployed - looking for first regular job	29,372	34,166
Unemployed - having lost or given up previous job	150,084	390,677
Total in labour force	2,109,498	2,232,203

Flooding

Water is a resource but it can also act as a threat to human beings in the form of flooding which results in extensive environmental, economic and social problems. Ireland has experienced periods of extreme weather conditions in the number of years that have resulted in coastal, fluvial, and pluvial flooding around the country, affecting buildings, residences, and causing extensive economic damages. The EU introduced the Flood Directive [2007/60/EC] that addressed management of flood risk and required member states to carry out Preliminary Flood Risk Assessments (PFRA), flood maps, and flood risk management plans. It was transposed into Irish law under Statutory Instrument 122 of 2010. The OPW was given the responsibility of implementing the Directive through the National CFRAMs, which began in 2011, and consisted of the following phases: Preliminary Flood Risk Assessments (PFRAs), Catchment Flood Risk Assessment and Management (CFRAM) studies, and implementation and review. Since flooding has a moderate to severe effect on human beings, prevention measures and appropriate management plans are necessary and should continue to be implemented in local, regional, and national development plans.

Arterial Drainage Maintenance Activities aim to maintain the channels that were introduced in catchment areas for the purpose of preventing or substantially reducing the periodical flooding of lands or improving by drainage lands (OPW, 2009). There have been substantial social and economic benefits from the drainage of marginal land. In Ireland, land, houses and roads have been mitigated to some degree in areas where the Arterial Drainage Programme has been implemented. These channels need continuous maintenance over time due to changes in flow rates, sediment loading or accumulation, which could potentially increase flood risk. Arterial Drainage Maintenance Activities (2016-2021) involve the removal of build-up of foreign or natural material that impedes the free flow of water such as the removal of water-entrained silt and associated vegetation, or repairing channel breaches from erosion (OPW, 2009). These activities prevent the channel from deteriorating in the long-term and potentially increasing the risk of flooding. It should be noted that the design standard of flood alleviation schemes is usually the 1% AEP (Annual Exceedance Probability) in comparison to the 2% or 5% AEP level of protection provided by Arterial Drainage Schemes. Arterial Drainage schemes have the potential to increase flood risk elsewhere in the catchment where increased conveyance through channel maintenance results in a faster response of catchments to runoff.

Landscape

Ireland is a popular tourist destination due to its beautiful scenery and features. Several policies, plans and strategies have been introduced in order to ensure that these views are recognised and protected. The Planning and Development Act 2000 contains provisions that relate to the preservation and conservation of the landscape. Sections 10, 202, and 204 of the Act, which give local authorities the discretion to include objectives on the conservation of landscapes within development plans or the power to designate areas for protection. Other plans in place that recognise the importance of Irish landscapes are the National Landscape Strategy for Ireland 2015-2025, National Spatial Strategy (NSS) and National Guidelines. Many scenic views and routes in rural and urban landscapes around Ireland have been acknowledged in Development Plans. A large number of Local Authorities have prepared Landscape Assessments for their relevant county.

Amenity/ Recreation

Rivers, lakes, and coastal areas are key components to tourism and recreation supporting activities such as fishing, bathing, sailing, recreational boating, bird watching, nature walks, and kayaking/canoeing. There are 135 designated bathing areas in Ireland with majority of the areas achieving a high quality of water and meeting the required EU standards. The revised Bathing Water Directive (2006/7/EC) prioritises human health, proactive management of water quality, and increased public participation. Inland recreational activities consist of golf, horse racing, hurling and Gaelic football, which are spread out throughout the country and have their own facilities throughout.

Fisheries and angling

Ireland is recognised as being an outstanding fishing holiday destination in Europe. The vast variety and quality of fishing in Ireland makes it a perfect destination for angling. There is a wide range of angling options for enthusiasts such as coarse, pike, sea, game, salmon, and sea trout angling. Popular areas for fish and angling consist but are not limited to the Erne and South Donegal for coarse angling; Kilmore Quay, Shannon Region, Clew Bay and the North Western region for sea angling; the River Feale, the River Suir, Lough Conn and Lough Cullin for game angling; the River Moy and the River Eany for salmon angling; Lough Owel, Lough Sheelin, Lough Arrow, Lough Doon, and River Annalee for sea trout angling. Arterial Drainage Maintenance Activities (2016-2021) may create access routes and paths along the river corridors which could be used for recreational and community purposes.

Tourism

The Tourism Trends report assessed the international and domestic tourist patterns of visitors to the Republic of Ireland. According to the assessment, in bound tourism traveling to the Republic of Ireland increased by 19% to 7,839,000 between 2004 and 2008, with an average length of stay of 8 days (CSO, 2008). The majority of visitors come from the EU, closely followed by the US and Canada. Dublin continues to be the most popular destination by international tourists, followed by the South West Region. Domestic tourism in Ireland is most common in the southern or eastern regions of the country. One-third of the trips are for family/friend visits and the rest are holidays or special occasions (CSO, 2008).

The Wild Atlantic Way is an enchanting and culturally rich coastal touring route. It is a 2,500 km stretch of picturesque rugged coast along the west of Ireland. Surrounded by soaring mountains, jutting headlands, breath-taking cliff faces and lush green forests. Where you're seeking an epic adventure or a remote, tranquil getaway.

Ireland's Ancient East is a new touring region with 5,000 years of history ranging from passage tombs to Palladian mansions through south and east. It is a geographical area that visitors are invited to explore. Tours, walks, festivals, and events are promoted along the following counties, Cavan, Monaghan, Louth, Longford, Westmeath, Offlay, Lois, Kildare, Kilkenny, Waterford, Wicklow. Dublin, Tipperary and Cork. The touring region has been themed along four pillars:

- Ancient Ireland
- Early Christian Ireland
- Medieval Ireland
- Anglo Ireland

Arterial Drainage schemes/channels/ overlap many tourist sites.

6.2.2 Threats to human beings

- It is important to consider the areas where the works are being carried out and its susceptibility to flooding. Consider residences/housing locations both upstream and downstream of the works. It is necessary to ensure that the works will not increase the risk of flooding (i.e. complete removal of treeline/riparian vegetation, increases erosion and in turn rate at which runoff and sediment discharge to watercourses) by impacting the flows or removing areas of water accumulation/storage. The consideration for areas both upstream and downstream of the potential works is crucial.
- OPW Arterial Drainage Schemes are designed to reduce flooding of agricultural land on average to the one in three annual probability design standard. Therefore, increased flood risk from climate change and changes in land management practices may not be mitigated through Arterial Drainage Maintenance Activities (2016-2021).
- In-channel works have the potential to cause diffuse pollution or release of suspended solids which could impact water quality, directly or indirectly, affecting angling or recreation activities
- The Wild Atlantic Way and Ireland's Ancient East are two major touring routes/destination themes which cover the majority of the areas included in the Arterial Drainage Maintenance Scheme. The high quality environment is a key selling point of these destinations, therefore any risk of degradation of environment and aesthetics posed by the Arterial Drainage Maintenance Activities (2016-2021) could be a threat to tourism and recreation based economy.

6.2.3 Opportunities for human beings

- Some flood risk alleviation for residences in close proximity to channels as a result of drainage and maintenance. It is also important to recognise the benefit of drainage schemes and maintenance activities for agricultural and benefitting lands.
- Where possible the maintenance activities could enhance the landscape character of the river corridors or channels in sections with valuable landscape characteristics Maintenance activities such as trimming of trees/branches, tree cutting, or bank protection can in some cases create or clear access routes and/or paths along the river corridor which can be used for tourism or recreational purposes (angling especially) as experienced in various areas along the Moy Arterial Drainage Scheme.

6.2.4 Future Trends

The general trend in terms of population growth and distributions in Ireland continues to be a slight annual increase in population and a movement towards larger towns and cities (CSO, 2012). Immigration numbers continue to increase and emigration numbers are slowly declining, as the Irish economy is improving. The growth of population will create a pressure in urban fringes and rural areas. A rise in housing and infrastructure development will be needed to accommodate the population numbers and movement. This includes water infrastructure and the

associated demand for abstraction and discharges of waste water. The growing population will also require a demand for amenity and recreation areas. Waterbodies are likely to be areas of potential opportunity for housing, recreational, or tourism development. It is crucial to consider risk of flooding in future housing of recreational developments.

Domestic and international tourism will continue and there will be a potential for more development and promotion of outdoor, adventure, and cultural destinations. Tourism way points in rural areas can be beneficial socially and economically, and they will require access road improvement and potentially more development.

At the moment, Arterial Drainage Schemes benefit rural populations as it allows landowners to install field drainage, which reduce waterlogging of land and enabling more livestock or higher crop yields. If the shift from rural to urban habitation continues the relative priority of maintaining current levels of flood risk in urban and rural watercourses may change. This could conflict with agricultural productivity goals and the safeguarding of this land. Maintaining a close look at population dynamics, development and agricultural productivity and demand will be essential for economic justification in planning future Arterial Maintenance Activities, should budgets be constrained.

6.3 Water

6.3.1 Introduction

Water is a very important resource and appropriate management is crucial to secure our current needs and the needs of future generations. Water quality in Ireland faces a major threat from pollution, caused by point sources such as discharges from waste water treatment plants and industry, and diffuse sources such as septic tanks, agriculture and forestry. The European Union (EU) Water Framework Directive (WFD) is the primary legislation for achieving sustainable management of water quality and resources in Ireland. The WFD was implemented in 2000 as a European-wide law that encouraged a communal goal to protect all water and water dependent ecosystems; groundwater systems, rivers, lakes, transitional waters, coastal waterbodies, and wetlands (EC, 2000). The main goals of the WFD are to maintain high and good status waters where they already exist and restore waters that are unable to support aquatic ecosystems sufficiently (EPA, 2012). To implement the requirements of the WFD, Ireland was divided into seven River Basin Districts (RBD) and River Basin Management Plans (RBMP) were developed to assess and monitor surface water and groundwater of each RBD. The RBMP aimed to classify the water by their quality status and setting objectives with the aim to protect and improve water quality in accordance with the WFD goals. The RBMP use data collated by the EPA and partner organisations (i.e. Inland Fisheries Ireland).

Water quality in Ireland is reasonably good compared to other EU countries (EPA, 2016b), however, there are still challenges such as point source pollution, as well as, nutrient and sediment loading that have to be addressed through legislative measures and administrative systems.

The second cycle of River Basin Management Plans 2015-2021 is underway. The Draft reports are expected to be ready for public and statutory consultation between December 2016 and June 2017. The approach for the second cycle will be different as the Eastern, South Eastern, South Western, Western, and Shannon RBD will be merged into one National RBD. The North Western and Neagh Bann International RBD will be assigned a single administrative area in the Republic of Ireland. This approach aims to facilitate the assessment and reporting aspect, however, there will still be regional administrative structures to support the implementation of the plan (EPA, 2016).

The Environmental Protection Agency (EPA) has various responsibilities under the European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003), which come under the category of "coordination and oversight". The EPA runs a monitoring programme that covers groundwater and surface waters: rivers, lakes, coastal and transitional waters.

6.3.2 Water Quality

For the WFD, water quality is measured in ecological status or ecological potential for artificial or heavily modified waterbodies. The ecological status of surface water is based on the assessment of specified biological quality elements, as well as supporting hydromorphological quality elements, chemical (specific pollutants), and physico-chemical elements (EPA, 2015). Figure 6-1 outlines the assessment process for ecological status.

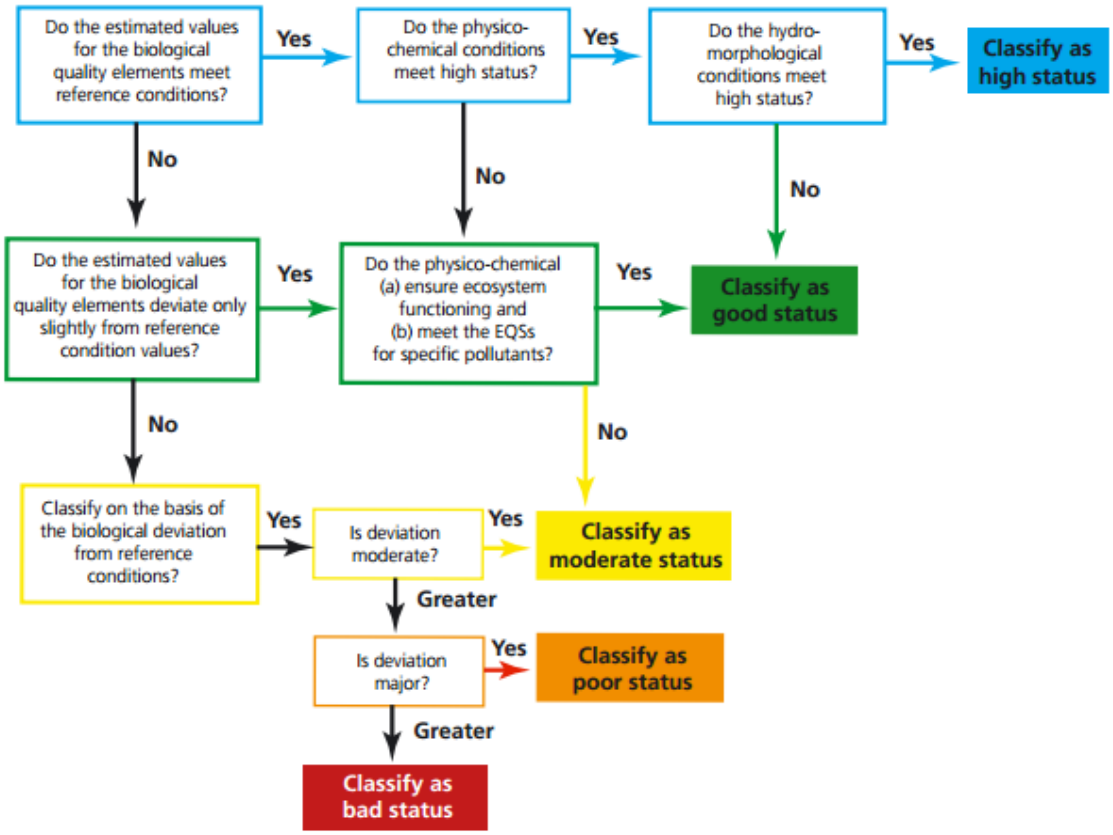
The physico-chemical quality elements are assessed by monitoring and routine sampling of feeder streams which can be a source of nutrient and organic enrichment to the main channels. Depending on their location the feeder streams can be vulnerable to point source pollution from municipal infrastructure or diffuse pollution from agricultural runoff.

Hydromorphology conditions can only downgrade waterbody status from high to good. Hydromorphological pressures are relevant in relation to potential impacts on benthic invertebrates and fish populations. The link between these pressures and ecological status in Irish waters is not explicit and needs further investigation to determine the extent to which hydromorphological alteration of drainage schemes, embankments and flood relief schemes influence indicators of biological and physico-chemical conditions.

Hydromorphological quality is currently assessed using RHAT methods and only 241 of the 3142 river waterbodies have been assessed in the latest 2015 water quality tables available from the EPA.

Many surface waters (rivers, lakes, and coastal waters) are controlled or have been modified to support flood protection, navigation, freshwater supply, drainage or hydropower production, yet the ecological impacts of these alterations are difficult to quantify (EPA, 2015). No waterbodies subject to Arterial Drainage Schemes have been classified as Heavily Modified Waterbodies or Artificial Waterbodies and are as such assessed for good ecological status under the WFD (according to the latest GIS waterbody data).

Figure 6-1: Role of different quality elements in the assessment of ecological status of surface waters (EPA, 2015).



The preliminary results of the water quality assessment for Ireland for 2013-2015 as presented in the EPAs 2016 State of the Environment Report 2016 (EPA, 2016) (see Table 6-3 and Figure 6-2) concluded that:

- 69% of the length of river channels are at high or good status
- 46% of lakes monitored are at high or good status
- 37% of transitional waters are at high or good status
- 76% of coastal waters are at high or good status
- 99% of the area of groundwater bodies are at high status.

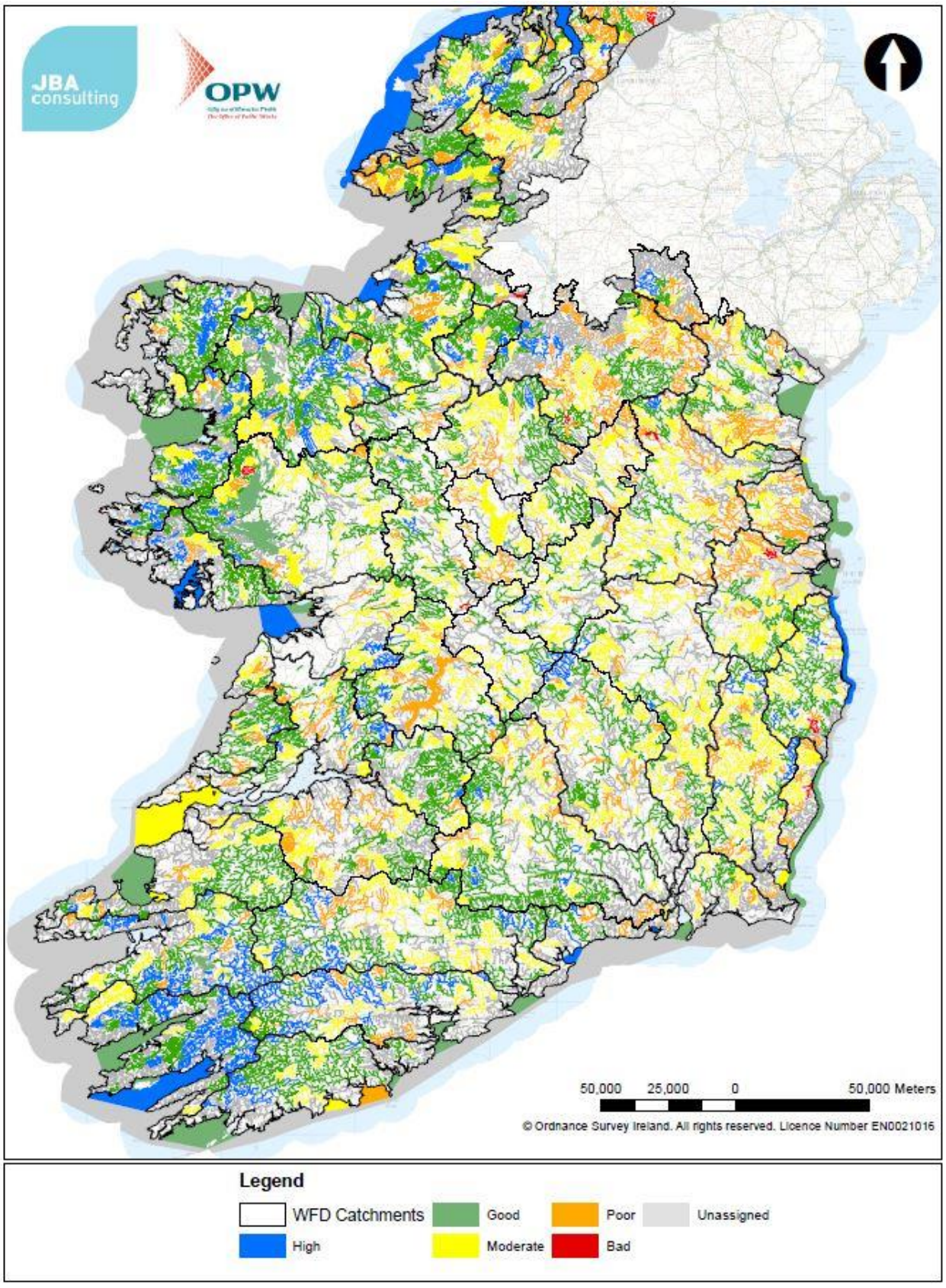
Table 6-3: Summary of WFD water surface water (ecological status) and groundwater (chemical status) 2013-2015(Source: EPA, 2016)

Status of Irish Waters (2013-2015)	High	Good	Moderate	Poor	Bad
Groundwater (% area) (interim status)	99	0	0	1	0
Rivers (% length of water bodies)	21	48	20	11	0
Lakes (% water bodies)	11	35	33	13	8
Transitional (% area)	23	14	38	7	2
Coastal (% area)	47	29	14	2	0
N.B. 16% of transitional and 8% of coastal waterbodies are unassigned.					

The 2016 State of the Environment reports that ecological status has not improved since the first river basin management cycle. The report states that while the overall length of unpolluted river channel has remained relatively constant there has been a substantial loss in the number of sites where the highest quality river sites are found i.e: Q5 rated sites. The latest round (2013-2015) of sampling and analysis shows that only 21 sites were classified as the highest quality river. Earlier sampling regimes undertaken in 1987 and 1990 showed higher numbers of highest quality rivers (575 between 1987 and 1990 and 82 between 2001 and 2003).

The OPW Arterial Drainage Schemes (channels, embankments, flood relief schemes) are distributed all throughout Ireland and have the potential to directly or indirectly, impact on surface water and groundwater across the country.

Figure 6-2. Surface water ecological status for rivers, lakes, transitional and coastal waters (2010-2012)



6.3.2.1 Rivers

The rivers in Ireland are regularly monitored to assess water quality, trends, ecological and physico-chemical status. Under the WFD, surface waterbodies are classified into five ecological status classes using a combination of biological quality elements, such as macroinvertebrate fauna, macrophyte flora, fish communities, the supporting general physico-chemical conditions, and hydromorphology. Parameters for water quality measures include nitrate, phosphate, suspended solids, BOD, and ammonia. The water status assessment for 2010-2012 displayed that over fifty-percent (53%) of the surface waterbodies monitored (858) were found to have a satisfactory (i.e. high or good) ecological status as displayed in Table 6-4 and Figure 6-3. The results for 2013-2015 have not yet been published by river basin district.

The biological pollution assessment used to monitor water quality is macroinvertebrate monitoring and assessment method (Q-values) due to its sensitivity for detecting organic pollution and nutrient enrichment impacts on Irish Rivers (European Commission, 2013). Approximately 13,300 kilometres of river channel were examined using biological Q value scheme. Water quality results of rivers with high or good ecological condition were roughly 73% of the monitored channels displaying satisfactory or unpolluted conditions (Figure 6-3 and Figure 6-4).

The majority of the rivers fulfilled the Environmental Quality Standard (EQS) for specific pollutants (0.035mg/l P). The main threat continued to be naturally occurring metals present in mineral-rich mining areas (EPA, 2012). The EQS for 'priority and priority hazardous substances' were polyaromatic hydrocarbons (PAHs) and mercury, among others. A decline of nitrate concentrations in rivers, especially those located in proximity to intensive agricultural areas was also observed. However, nutrients (phosphorus/nitrogen) remain the main impact of eutrophication because of nutrient loading and oxidising conditions. Pollution caused by urban wastewater discharge and industrial pollution decreased from 53 km to 17 km of river channel, since the previous assessment in 2007-2009(EPA, 2015). However, agriculture and municipal sources remain the primary cause of pollution, accounting for 53% and 34% respectively (EPA, 2015).

Ecological quality status is not only affected by the inflow of pollution, but it can also be altered by alterations to the river (widening of the channel, the introduction of weirs, creation of embankments or flood walls), which can change the hydromorphological conditions of the river. The deepening and widening of river channels to increase the capacity to contain floodwaters and to provide an outfall for drainage from agricultural land, could result in significant modifications to hydromorphology. Such modifications and their maintenance can have knock on impacts to the ecology of the catchment in response to changes in flow regime, water quality and sediment regime.

It is difficult to measure the extent to which National Arterial Drainage Maintenance Activities may impact the ecological status of surface water and groundwater bodies. Continued monitoring of hydromorphology, turbidity, suspended solids and sedimentation, ecology, and spawning beds of catchments and river reaches subject to Maintenance Activities could provide an indication of the potential level of influence/impact of the works.

Table 6-4. Ecological Status of monitored rivers by RBD for period 2010 to 2012 (EPA, 2015).

River Basin District	Number of Water bodies	High	Good	Moderate	Poor	Bad	Total
South-Western	278	71	132	62	13	0	278
		26%	47%	22%	5%	0%	100%
Western	276	52	139	62	21	2	276
		19%	50%	22%	8%	0.7%	100%
North-Western	213	21	72	45	71	4	213
		10%	34%	21%	33%	1.9%	100%
Shannon	393	25	176	108	81	3	393
		7%	45%	27%	21%	0.8%	100%
South-Eastern	285	17	103	117	47	1	285
		6%	36%	41%	16%	0.4%	100%
Eastern	144	5	37	58	43	1	144
		3%	26%	40%	30%	0.7%	100%
Neagh Bann	35	1	7	12	15	0	35
		3%	20%	34%	43%	0%	100%
National	**1,624**	**192**	**666**	**464**	**291**	**11**	**1,624**
		11.8%	41.0%	28.6%	17.9%	0.7%	100%

Figure 6-3. Percentage breakdown of the monitored river waterbodies (RWB) within each RBD showing ecological status (2010-2012)

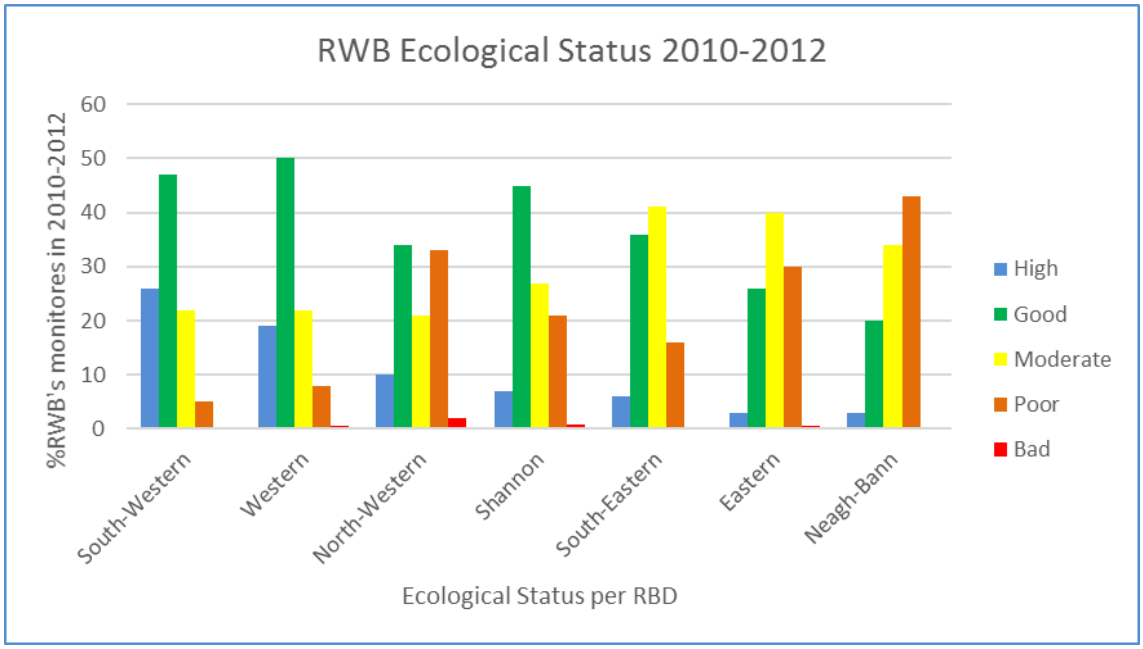
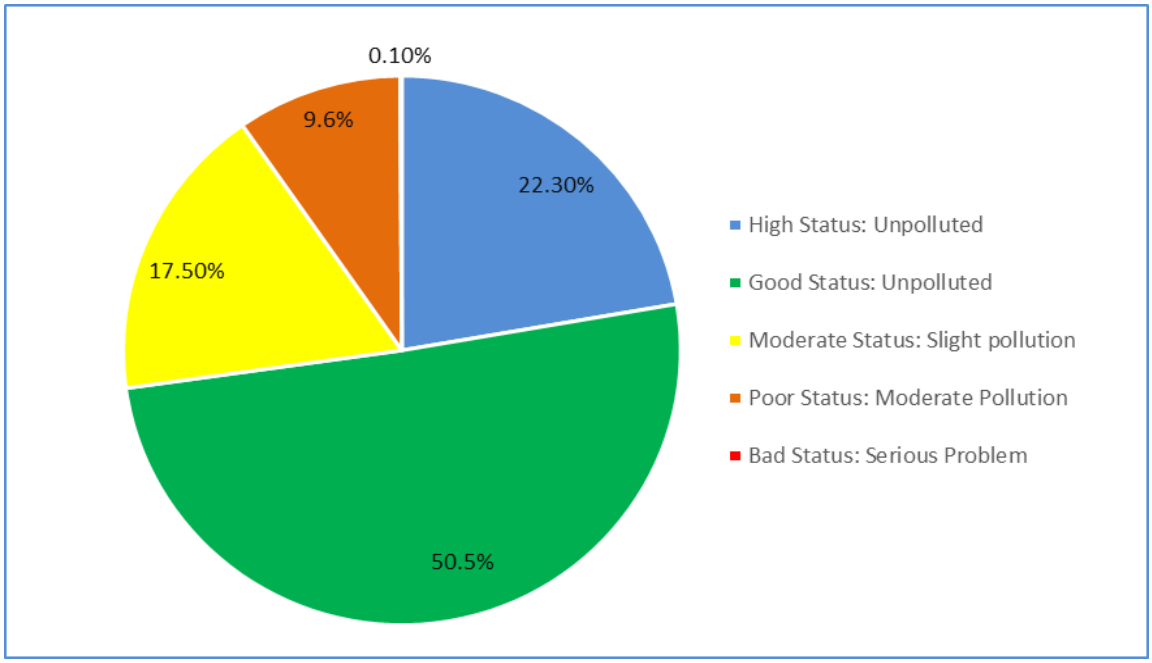


Figure 6-4. River quality 2010-2012: Biological Pollution Assessment (Source: EPA, 2015).



6.3.2.2 Lakes

There are over 12,000 lakes in Ireland, primarily located in the west and the centre of the country. There were 213 lakes monitored for the WFD assessment (2010-2012). Biological and chemical parameters were evaluated with 43% (91 lakes) of the monitored lakes achieving 'high' or 'good' status' targets of WFD (EPA, 2015). Between 2007 and 2009, 48% (101 lakes) were considered high/good status, which means that a 5% decline was experienced in the 2010-2012 assessment (EPA, 2012), as illustrated in Table 6-5,

Figure 6-5, and

Figure 6-6.There was also an increase in the number of lakes that fell into the poor ecological status category. The monitoring programme and classification criteria needs to further investigate the cause of variability and changing conditions of each lake.

Preliminary results for the 2013-2015 water status assessment, as presented in the 2016 State of the Environment Report (EPA, 2016), show that 54% of the monitored lakes are impacted (moderate or worse status). This is a 3% increase in this category when compared to the 2007-2009 baseline.

The assessment of hydromorphological condition was responsible for the downgrade of four otherwise high-status lakes: Doo Lough, Guitane, Nahasleam, and Pollacappul. However, there was no evidence that these four lakes were actually impacted by nutrient enrichment. Lough Guitane was assigned a good status in 2010-2012 because hydromorphology was not considered. However, when considered, it became evident that the lake was subject to water level fluctuations and it only contained a soft engineering bank protection structures, both which resulted in high hydromorphological pressures.

As an indication of the scale of possible impacts that may arise from arterial drainage maintenance activities 84 out of the 818 lake waterbodies are within 1 kilometre of an arterial drainage channel.

Table 6-5.The breakdown of ecological status from the periods of 2007-2009 and 2010-2012

	2007-2009				2010-2012			
Ecological Status	**Number of Lakes**	**% of Lakes**	**Surface Area**	**% Area**	**Number of Lakes**	**% of Lakes**	**Surface Area (km2)**	**% Area**
High	27	13	111	12	23	23	38	4
Good	74	35	309	33	68	68	257	27
Moderate	75	35	285	30	70	70	287	30
Poor	22	10	189	20	33	33	354	37
Bad	14	7	52	2	19	19	19	2
Total	**214**		**946**		**213**	**213**	**955**	

Figure 6-5. 2007-2009 WFD (a) Percentage lakes and (b) percentage of lake area surveyed assigned to each category (Source, EPA, 2015)

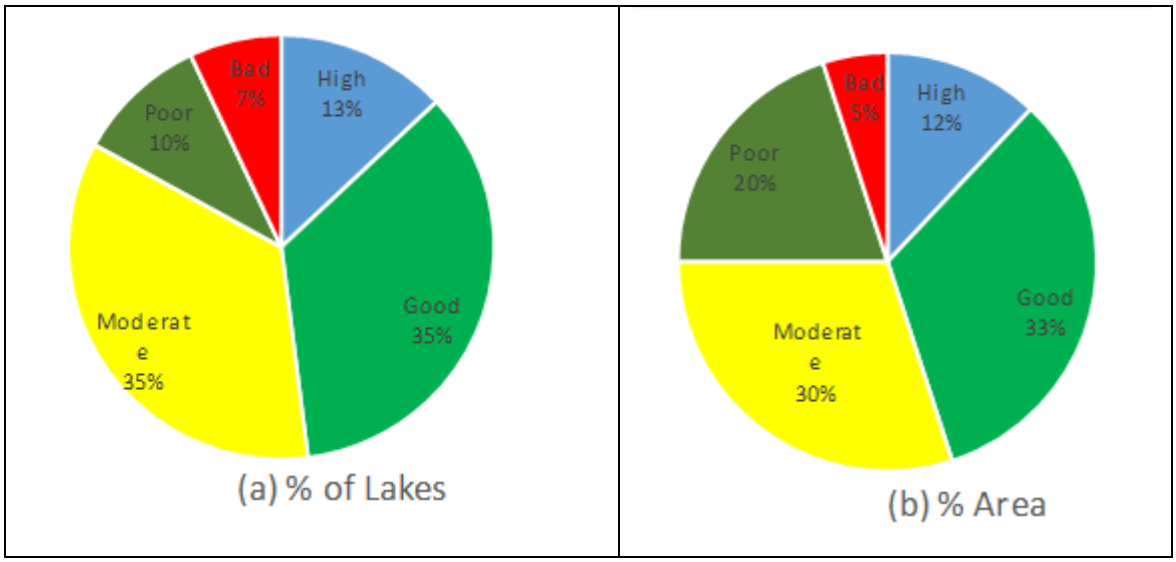
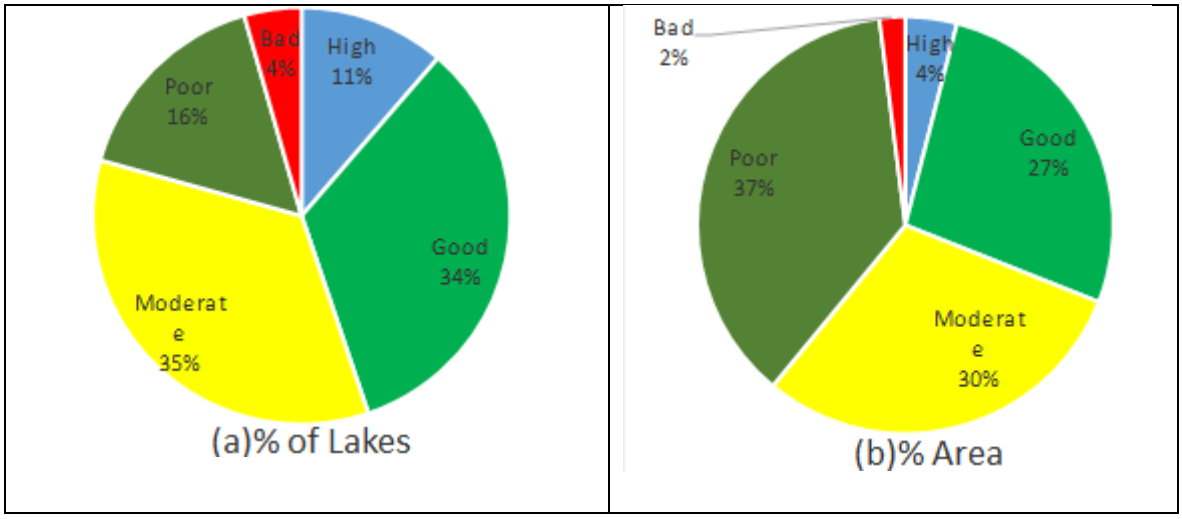


Figure 6-6. 2010-2012 WFD (a) Percentage lakes and (b) percentage of lake area surveyed assigned to each category (Source: EPA, 2015)



6.3.2.3 Transitional and Coastal Waters

Coastal and transitional waterbodies are under a range of human threats such as discharge from industrial and municipal wastewater treatment plants, inputs from diffuse agricultural sources, harbour and port activities, and discharge of marine vessels. The EPA assessed 193 transitional water bodies between 2010 and 2012 and discovered that over one-third (36 percent) was found to be at good or high ecological status (EPA, 2012). Of the 101 coastal waterbodies assessed, 93 percent received a high or good ecological status, which demonstrate that these waters have the capacity to support ecologically diverse marine communities (EPA, 2015). Transitional waters, on the other hand, have a much lower percentage of high or good waterbodies demonstrating greater human influence and activity, directly affecting water quality. From the transitional and coastal bodies assessed in Ireland, 27% of the waterbodies may be at risk of not being capable of supporting the biological element due to the degree of structural modification (hydromorphological pressures).

6.3.2.4 Groundwater

Groundwater is an important source of drinking water in Ireland, providing approximately 25 percent of drinking water nationally (EPA, 2015). In 2012, the EPA's assessment of the groundwater bodies in Ireland determined that only 1.5 % (11) groundwater bodies were classified as poor chemical status based on the best available data. Table 6-6 summarises the status of groundwater in all the RBD and Table 6-7 displays a comparison of the status of groundwater bodies in May 2011 and December 2014.

Table 6-6. Groundwater chemical status 2014 (Source: EPA, 2015)

Qualitative Status	Good		Poor	
RBD	**Waterbodies (No.)**	**Area km2**	**Waterbodies (No.)**	**Area km2**
Eastern	73	5,789	2	477
South-Eastern	149	12,869	2	24
South-Western	83	11,284	1	6
Shannon	236	17,503	6	97
Western	104	11,732	0	0
North-Western	72	7,421	0	0
Neagh Bann	28	1,805	0	0
National Total	**754 (98.5%)**	**68,403 (99%)**	**11 (1.5%)**	**604(1%)**

Table 6-7. Summary of December 2014 status update results with summary of 2011 results for comparison (Source: EPA, 2015)

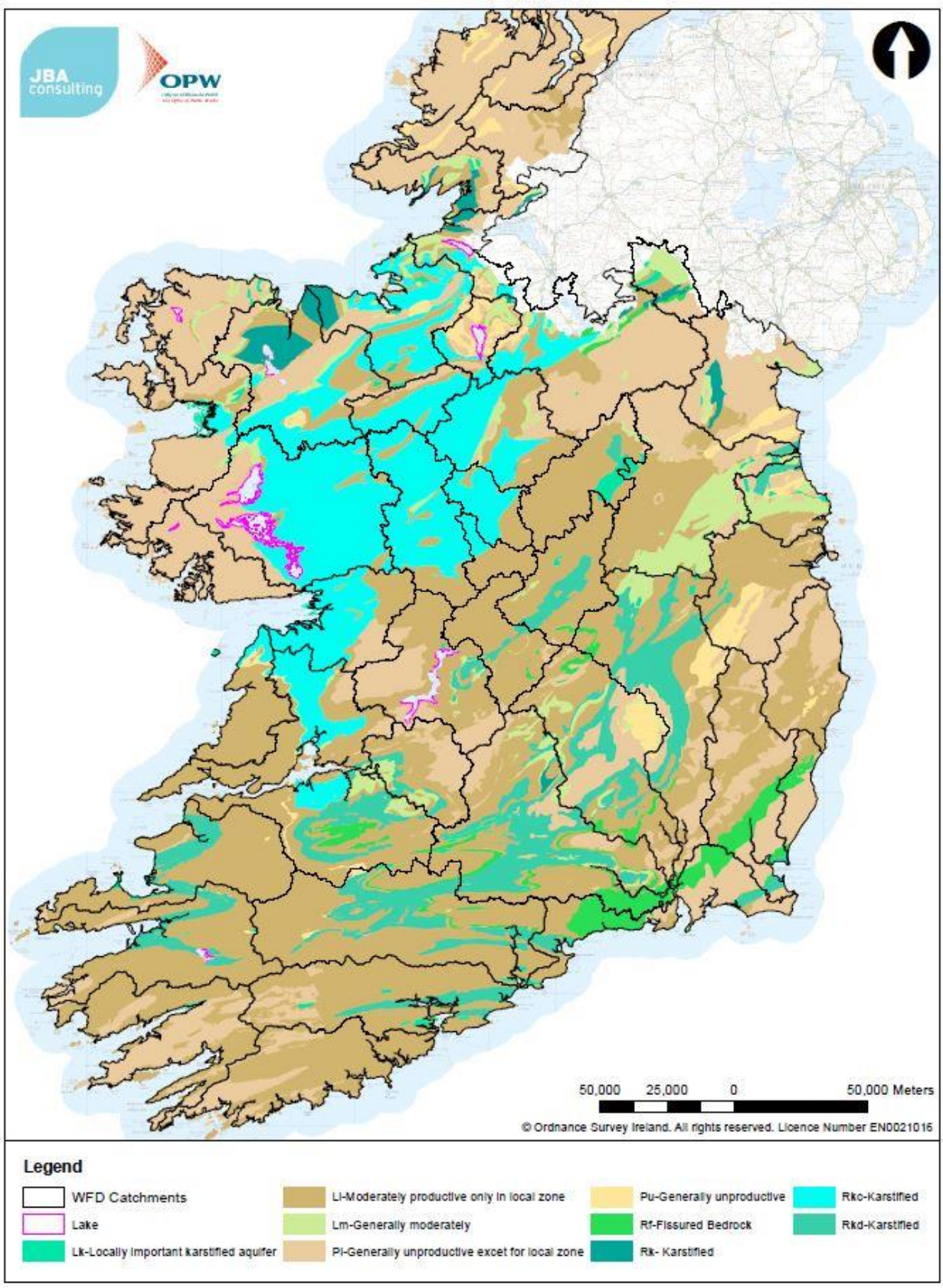
Groundwater Test	May 2011 Summary		December 2014 Summary	
	Good Status	Poor Status	Good Status	Poor Status
Overall Chemical Status	653	103	745	11
Overall Quantitative Status	753	3	754	2

On average the nitrate and phosphate concentration in groundwater was below the threshold on monitoring locations during 2007-2012. A reduction in detection of faecal coliforms (*Escherichia coli*, *Cryptosporidium*) was also observed during the study period, however, its presence continues to be a threat in vulnerable karst areas. 51% of groundwater samples were contaminated with faecal coliforms, which pose a challenge to protect public and private drinking water (EPA, 2012).

Groundwater is stored and flows through the pore spaces of sand and gravel deposits and fractures in bedrock. If the geologic deposit can yield enough water for a significant supply, then it is referred to as an aquifer. Approximately 26 percent of public and private drinking water supply in Ireland is provided by groundwater or spring source (EPA, 2012).The interaction between groundwater and surface water is complex and the quantification of the volume of groundwater that contributes to surface water flow (EPA, 2008). Bedrock aquifers have groundwater flow through fissures or fractures, therefore pollution or contaminants undergo minimum attenuation. Sand and gravel aquifers are the only aquifers with intergranular permeability (overlaying soils and subsoils), however they only account for approximately 2% of aquifers in Ireland. A large proportion of the productive aquifers in Ireland are karstified limestone, which are developed in rocks that are readily dissolved in water (refer to Figure 6-7).

The issue of rejected recharge in the context of unproductive aquifers could have implications on the impacts of drainage maintenance activity. These aquifers have low permeability, storage and transmissivity which may contribute to greater surface runoff during storms and surface water ponding.

Figure 6-7. Simplified Groundwater Flow Regime of Ireland (Source: GSI)



Pollution

Eutrophication and nutrient enrichment continues to be the main issue facing Irish waters with trends of both nitrogen and phosphorus continuing to be positive (EPA, 2012). The two most suspected causes of diffuse pollution of rivers are agriculture and municipal sources.

Agriculture, primarily diffuse agricultural pollution, results in eutrophication and was the main suspected cause of slight pollution, indicated by a moderate status under the WFD assessment (EPA, 2015). Municipal sources such as municipal wastewater, urban run-off, landfills, septic tanks and water treatment work are the major causes for nutrient enrichment. Industrial and forestry pollution are another source of pollution resulting in eutrophication, which is enhanced by phosphorus and nitrogen input. Siltation is an effect caused by municipal sources as well as engineering works such as dredging, civil works, and peat harvesting. Sensitive species such as Freshwater Pearl Mussel and fish can be impacted by the smothering effect of inert organic silt on waterbody substrates from the activities mentioned previously.

Siltation is also caused as a result of bank erosion, cattle access to streams, and losses from tillage land. The 2016 state of the environment report (EPA, 2016) has found that there are few studies to evaluate the effectiveness of riparian mitigation measures, such as fencing, in restricting cattle access and subsequent impacts. The EPA has commissioned the Cosaint research project to investigate the issues.

The Teagasc Agricultural Catchments Programme (ACP) objectives are to provide scientific evaluation of the effectiveness of the EU Nitrates Directive National Action Programme.

The Urban Wastewater Treatment in 2015 report (EPA, 2016b) has found numerous deficits in the treatment of urban wastewater in Ireland, with raw sewerage routinely discharged into rivers, estuaries or coastal waters in 43 locations. 142 urban areas have been identified for improvements.

Domestic waste water treatment systems are individually local point source pollution sources and can contribute to diffuse pollution although the Surface Water Regulations has helped to improve discharges from septic tanks. Arterial Drainage schemes and their continued maintenance can potentially enhance the performance of such systems through improving soil drainage conditions for percolation areas and tertiary treatment.

The sensitivity to pollution varies in relation to receiving environments, habitats and species.

6.3.3 Threats to water

Arterial Drainage Maintenance Activities proposed on the river channels have the potential to change the hydromorphological condition of the waterbodies resulting in alterations in water quality through increased sediment and nutrients loading from dredging or similar works. Drainage activities could potentially impact surface waters by impacting both the fluvial geomorphological processes and the features these processes create, which can result in habitat degradation that could impact the WFD ecological status of the surface waters.

There are many protected species (Freshwater Pearl Mussel, Crayfish, Lamprey, fisheries etc.) that are very sensitive to pollution and could be directly or indirectly impacted by degradation of the ecological status of the watercourses (See Section 6.7).

There are further threats to water, of which maintenance activities can influence.

Drainage, flood relief schemes, maintenance and other channel works

- Drainage works and maintenance of existing schemes may cause deterioration of water quality due to the introduction (or continuation) of more direct routes for pollution to enter the waterbody, bypassing natural purification processes which occur on the soil. In some cases, drainage works contribute directly to pollution through the introduction of eroded bank material, release of nutrients from sediments or creating an outflow from highly mineralised groundwater zones (Whiteley, 1979).
- Hydromorphological changes such as sediment production, water/sediment/wood flux, river channel adjustment, lateral connectivity which influence processes (i.e. pools, riffles, bars) can lead to habitat degradation, impacting the WFD ecological status. This could be indirectly through the impact on biological and physico-chemical conditions or directly on hydromorphological conditions.
- Changes in water quality could create pressure and impacts on the ecological and chemical status of waterbodies: river, lakes, ponds, standing waters, and other wetlands including peatlands.
- Arterial Drainage Maintenance Activities (2016-2021) works should not interfere in accomplishing the goals set out by the WFD, the second cycle of RBMP objectives, and

any other programmes or measures that aim to ensure the sustainability of water resources or water quality.

Pollution and Eutrophication

- Chemical, physio-chemical and biological potential of surface water bodies face major pressures which comprise of diffuse pollution of fine sediments and other pollutants such as nutrients from the agriculture and industry.
- There could be potential impacts on drinking water abstraction points downstream of proposed maintenance activity sites. In some cases, arterially drained channels can act as pathways to pollutants into other watercourse or groundwater/aquifers.

Climate Change

- Climate change impacts on water quality due to increased storm events, rainfall and flooding with the potential to change hydromorphology of river beds, cause bank erosion, and re-suspended nutrients. Changes in storm and rainfall regime, such as periods of repeat storms may also impact the water environment.
- Sea level rise will alter the salinity or surface and groundwater bodies and may result in changes to transitional waterbody boundaries. Sea level rise may also alter the performance of arterial drainage schemes and embankments.

Diffuse Pollution (e.g agriculture)

- Agricultural intensification could lead to increased concentrations of nitrates and phosphates, in particular in areas of high agricultural productivity where such concentrations are already elevated. Arterial Drainage Schemes may contribute to continued or further agricultural intensification.
- Continued maintenance of arterial drainage schemes may further increase or continue current rates of discharge of nitrates and phosphates into watercourses and transport downstream.

Point Source Pollution (e.g. urban wastewater)

- Continued maintenance of arterial drainage schemes may further increase or continue current velocities and discharge rates which influence the concentration of urban wastewater discharges and transport downstream.

6.3.4 Opportunities for water

- Arterial drainage maintenance activities prevent the deterioration of channel conditions due to unprecedented erosion and/or blockage, which could result in diffuse pollution of the channel (erosion/sediment discharge) or increase flood risk. Maintenance works such as silt/vegetation management, bush cutting/branch trimming, aquatic vegetation cutting among other activities can help mitigate potential impacts and help improve the hydraulic connectivity of the channel.
- Integrated catchment management could reduce the silt deposition and vegetation growth in channels, which could reduce the frequency and scale of maintenance required.
- There are opportunities along river channels for river restoration and ecological enhancement beyond EREP criteria. The REFORM tools and guidance may present opportunities and mechanisms to implement catchment restoration whilst maintaining land drainage functions.

6.3.5 Summary Water Quality

The summary table below (Table 6-8) displays a catchment-wide assessment of water quality in Ireland and highlights the relevant OPW Schemes present in each catchment. Data on hydromorphological pressures was not readily available, however, it is an important feature that influences water quality status directly and indirectly as biological and phyisico-chemico

conditions, the inclusion of this category into the table was for the purpose of highlighting the data gap.

6.3.6 Future Trends

Surface water and groundwater are an important resource in Ireland. There are drivers and pressures that threaten water quality such as municipal point source pollution, nutrient and sediment loading from agriculture, among others. Better management and sustainable practices could help mitigate potential impacts. The implementation of RBMPs has started to demonstrate favourable results. Although the progress is slow, continued monitoring and development of catchment plans will affect the rate of change. The target to achieve 13.6% improvement in ecological status for surface waters from the 2009 baseline by 2015 were not likely achieved. The second cycle of RBMPs must include the targets for those waterbodies that did not reach their aim.

Further work, tests, risk characterisation of groundwater dependent terrestrial ecosystems (GWDTEs), and groundwater body boundary review were carried out in 2015 and will be included in the 2017 RBMP (EPA, 2015).

The second cycle of River Basin Management Plans 2015-2021 is underway. Climate change impacts projected in the coming decades include sea level rise, more intense storms and rainfall, increased magnitude and frequency of fluvial and coastal flooding. In a situation where more frequent flooding is likely, concern arises on its potential impact on water quality.

The introduction of the Protection of the Environment Act, 2003 and the licencing of large scheduled industries and waste facilities has helped to control discharges into water courses. Restrictions on the discharges of persistent organic chemicals (POCs) to the environment has assisted in the maintenance of freshwater, transitional and marine waters. The EPA has recently reported that in general water quality in Ireland is good but problems do arise at the local level. Consequently, as part of our recommendations, JBA is recommending that site specific pre- and post- maintenance activity surveys are conducted by the OPW or their agents. These surveys would facilitate site specific SOPs if necessary and site specific mitigation measures. This approach by the OPW would ensure minimal, if any, impact on local water sources/resources and would ensure the continual improvement of local ecosystems.

Table 6-8. Catchment-wide assessment of water quality in Ireland (Y or N recorded in presence or absence in catchment)

Catchment Name	Ecological Status	Groundwater Status	Risk Status	Nutrient Sensitive Areas	Hydromorphological Pressures	Recreational Water	Drinking Water	Water Dependant Habitat	Aquifer	OPW Scheme
Ballyteigue-Bannow	Poor	Good	Y	N		N	Y	Y	Y	Ballyteigue/Kilmore
Bandon-Ilen	Good	Good	N	Y		Y	Y	Y	Y	Bandon River (Dunmanway)
Barrow	Poor	Good	N	Y		N	Y	Y	Y	
Blacksod-Broadhaven	Good	Good	N	N		Y	Y	Y	Y	
Blackwater (Munster)	Good	Good	N	N		Y	Y	Y	Y	
Boyne	Poor	Good	N	Y		Y	Y	Y	Y	Boyne
Colligan-Mahon	Good	Good	N	N		Y	Y	N	Y	Brickey
Corrib	Good	Good	Y	N		N	Y	Y	Y	Corrib
Donagh- Moville	Poor	Good	Y	N		Y	Y	Y	Y	
Donegal Bay North	Poor	Good	Y	Y		Y	Y	Y	Y	
Dunmanus-Bantry-Kenmare	Good	Good	Y	Y		N	Y	Y	Y	Ouvane
Erne	Poor	Good	Y	Y		Y	Y	N	Y	Abbey, Duff and Kilcoo
Erriff-Clew Bay	Good	Good	N	N		Y	Y	N	Y	
Foyle	Poor	Good	N	N		N	Y	N	Y	Donegal
Galway Bay North	Poor	Good	N	N		Y	N	Y	Y	
Galway Bay South East	Good	Good	Y	Y		Y	Y	Y	Y	Gort and Lackan
Gweebarra-Sheephaven	Good	Good	N	N		Y	Y	Y	Y	
Laune-Maine-Dingle Bay	Poor	Good	N	Y		Y	Y	Y	Y	Maine
Lee, Cork Harbour and Youghal Bay	Good	Good	N	Y		N	Y	Y	Y	
Liffey and Dublin Bay	Poor	Good	Y	Y		Y	Y	Y	Y	Ryewater and Hazelhatch (Shinkeen)

Catchment Name	Ecological Status	Groundwater Status	Risk Status	Nutrient Sensitive Areas	Hydromorphological Pressures	Recreational Water	Drinking Water	Water Dependant Habitat	Aquifer	OPW Scheme
Lough Neagh + Lower Bann	Poor	Good	N	Y		N	Y	N	Y	Monaghan Blackwater
Lough Swilly	Poor	Good	Y	N		Y	Y	Y	Y	Donegal
Lower Shannon (A)	Good	Good	Y	Y		Y	Y	N	Y	Brosna
Lower Shannon (B)	Good	Good	N	Y		N	Y	Y	Y	
Lower Shannon (C)	Good	Good	Y	Y		Y	Y	Y	Y	Clareen, Nenagh, Woodford, Killmor and Carrigahorig
Lower Shannon (D)	Good	Good	N	Y		N	Y	Y	Y	Groody, Mulkear Ballymackeogh, Mulkear Cappamore
Mal Bay	Good	Good	N	N		Y	Y	Y	Y	Creegh and Cloghauninchy
Moy+ Killala Bay	Good	Good	Y	Y		N	Y	Y	Y	Moy
Nanny-Delvin	Poor	Good	Y	Y		Y	N	Y	Y	Duleek (Nanny), Matt, Broadmedow and Ward
Newry, Fane, Glyde and Dee	Good	Good	N	Y		Y	Y	Y	Y	Glyde and Dee
Nore	Good	Good	Y	Y		Y	N	Y	Y	Kilekenny
Ovoca-Vartry	Good	Good	N	N		Y	Y	N	Y	
Owenavorragh	Poor	Good	Y	N		Y	N	Y	Y	Owenavorragh
Shannon Estuary North	Good	Good	Y	Y		Y	Y	Y	Y	Shannon Embankment North, Sixmilebridge (Owenagarney),
Shannon Estuary South	Poor	Good	Y	N		N	Y	Y	Y	Deel, Maigue, Shannon Embankment South, Maigge outfall
Slaney + Wexford Harbour	Good	Good	N	Y		N	Y	Y	Y	
Sligo Bay + Drowse	Good	Good	Y	N		Y	Y	Y	Y	Bonet
Suir	Good	Good	N	Y		Y	Y	N	Y	Carrick-on-Suir
Tralee Bay-Feale	Good	Good	Y	Y		N	Y	Y	Y	Feale

Catchment Name	Ecological Status	Groundwater Status	Risk Status	Nutrient Sensitive Areas	Hydromorphological Pressures	Recreational Water	Drinking Water	Water Dependant Habitat	Aquifer	OPW Scheme
Upper Shannon (A)	Good	Good	Y	N		N	Y	N	Y	
Upper Shannon (B)	Good	Good	Y	N		N	Y	Y	Y	Boyle
Upper Shannon (C)	Good	Good	Y	Y		Y	Y	N	Y	
Upper Shannon (D)	Good	Good	N	N		N	N	Y	Y	
Upper Shannon (E)	Poor	Good	Y	Y		Y	Y	Y	Y	Ballyglass (Knockcrohery)
Upper Shannon (F)	Poor	Good	Y	N		N	Y	Y	Y	Inny
Upper Shannon (G)	Poor	Good	Y	Y		N	N	Y	Y	

6.4 Morphology, geomorphology, and hydromorphology

6.4.1 Introduction

Geomorphology is the study of the evolution and configuration of landforms. Similarly, hydromorphology is the relationship between hydrology and changes/alterations of underlying geology, whichis better understood when addressing structural features of watercourses and their continuity. Changes to catchments or river/lake/groundwater systems occur naturally or as a result of anthropogenic influence. Human alteration or morphological pressures are physical modifications made to rivers/lakes/groundwater systems to support activities such as navigation, urban development, or agriculture. These pressures consist of channelisation and dredging, river straightening, flood protection and embankments, impounding, water regulation and intensive land use. There are a significant portion of water bodies 'at risk' from hydromorphological pressures in Ireland as identified by the Characterisation and Analysis of Ireland's River Basin Districts (2005) and the EPA's Water Quality Report 2010-2012.

All water courses are reactive, responding to changes in the catchment by eroding and depositing sediment along its course. Reactivity levels vary dramatically with the type of system, where some are more prone to certain types and rates of change than others. An understanding of potential river response over time is invaluable in sustainably managing a river system. The ecological impacts of these hydromorphological modifications are poorly understood and the extent by which these impacts can be reversed or mitigated lack scientific evidence. For that reason, consideration of hydro-morphological conditions within the WFD is regarded by the European Commission as an area that needs improvement across the EU and therefore, hydromorphology will be a major focus in the 2016-2018 Common Implementation Strategy (CIS) work programme (EU, 2015).

Arterial drainage works and continued maintenance activities could impact the hydromorphological conditions of watercourses resulting in the following potential effects:

- Channelisation,
- Siltation,
- Disturbance to spawning habitat,
- Changes in water quality,
- Connectivity to floodplains and associated habitats,
- Changes to the sediment regime (e.g. shoaling),
- Connectivity to wetland and coastal habitats.

Drainage and channelisation are a major hydro-morphological pressures. Maintenance activities have the potential of altering fluvial and geomorphological processes such as sediment production, water/sediment/wood flux, river channel adjustment, lateral connectivity, as well as, the features that these processes create (pools, riffles, bars). These changes in the fluvial morphology of the surface water system can lead to habitat degradation, which in turn, can affect the WFD ecological status of the watercourses (See Section 6.7 Flora and Fauna).

River channel vegetation can influence hydromorphology and be driven by hydromorphology. The two should not be considered independently as arterial drainage maintenance activities include management of riparian vegetation and channel form.

6.4.2 Threats to morphology, geomorphology, and hydromorphology

- Diffuse pollution is the primary pressure causing siltation and degrading of spawning sites. Source mitigation measures are detailed in the WMUs linked to the implementation of Nitrate Regulations and the Agricultural Catchment Programme. Agricultural intensification is a key pressure here.
- Regardless of the rate, hydromorphological change will impact directly on water quality and flood risk by potentially altering the conveyance potential of the channel. Hydromorphological pressures are relevant in relation to potential impacts on benthic invertebrates and fish populations, but the link between these pressures and ecological status in Irish waters needs further investigation.

- In-channel maintenance work can lead to hydromorphological issues in the waterway, for example, the work can often reduce the roughness of the channel bed resulting in increased flow-rates. If the channel is not connected to the floodplain, the water volume will increase, resulting in more extreme flood peaks and potential flooding downstream.
- In-channel maintenance works can release entrapped nutrients in the sediments which may become available to the water bodies. Nutrients of particular concern would be nitrogen and phosphorus both of which are limiting nutrients and are associated with eutrophication in estuaries and freshwater respectively.
- Activities in the channel have the potential to disturb spawning gravels at a number of sites.
- Floodplain and coastal habitats are linked to river dynamics and must be considered during flood alleviation and engineered structure design.

6.4.3 Opportunities for morphology, geomorphology, and hydromorphology

- Proposed maintenance activities must be compatible with any WFD requirements to restore the natural morphology of waterbodies 'at risk' due to structural alterations.
- Siltation and shoaling of coarser material can compromise flood capacity and is common where channel dimensions have been increased, a hydromorphic assessment is needed to ensure WFD compliance.
- Some of the proposed Arterial Drainage Maintenance Activities (2016-2021) could have some benefit in managing hydromorphology impacted upon by other activities such as agricultural intensification or urbanisation.
- Opportunities along river channels for river restoration and ecological enhancement beyond EREP criteria. The REFORM tools and guidance may present opportunities and mechanisms to implement catchment restoration whilst maintaining land drainage functions.

6.4.4 Future Trends

In the 2010-2012 Water Quality Assessment in Ireland, hydrological conditions of a waterbody could only downgrade a site that was considered to be at High Ecological Status. However, fish and macro-invertebrates can also be affected by degraded hydrological conditions (i.e. Arterial Drainage Maintenance Activities) and therefore have the potential of impacting the entire spectrum of ecological statuses (High, Good, Moderate, Poor, Bad). The development of the physical habitat assessment River Hydromorphology Assessment Technique (RHAT) has increased the understanding of hydro-morphology and fluvial geomorphology. This is a growing field that will continue to experience invested interest and will continue to be mentioned and acknowledged in assessments that examine fluvial geomorphological processes, spatio-temporal variability, and geomorphic response to human modification. The understanding of hydromorphology will be beneficial in river characterisation and restoration measures.

The multiple pressures driving the status of a waterbody are difficult to isolate, however, eutrophication/nutrient enrichment and hydromorphological pressures are likely the major drivers. Ireland and the EU are in the processes of developing the best strategy for the assessment of hydromorphological conditions through projects such as the EU REFORM (Refer to Section 5.3.4.REstoring river FOR effective catchment Management (REFORM).

This adoption of REFORM methods and guidelines, RHAT evolution and updated hydromorphology standard. Even though RHAT is a useful tool for evaluating habitat condition, it does not assess the hydromorphological processes that create/eliminate the features recorded and therefore, it cannot provide the information needed for characterisation such as the identification of pressures, responses to pressures, and appropriate measures (Quinlan, 2015). A methodology developed in Italy known as the Morphological Quality Index (MQI) is a multi-scale assessment, where the reach scale is the basic spatial unit. The MQI assessment involves five steps and 28 indicators grouped into geomorphological functionality, artificiality, and channel adjustments (Rinaldi et al, 2015).

reflected in the Second Cycle of River Basin Management Plans (RBMP) has the potential of significantly influencing the nature of the National Arterial Drainage Maintenance Activities (2016-2021) and the National Implementation Strategy (2016-2018), where and how they can be applied, in the future.

6.5 Geology and soil

6.5.1 Introduction geology and soils

The underlying bedrock geology varies throughout the country. However, there is a large extent of limestone bedrock covering the north-western section of the island. The west and south of Ireland are composed of sandstone, siltstone, and mudstone bedrock underlain. The south east of the Island is mostly siltstone and mudstone, and a mixture conglomerates, schists, slates, muddy limestone and slates. The east of Ireland contains predominantly limestone, shale, and sandstone. The bedrock in the midlands are made-up of limestone among shale, and mudstone. There are areas which are karstic and may contain heritage or nature conservation significance such as turloughs, which are seasonal dry lakes, which fill up and drain with water (often very quickly), through a series of sink holes and fissures. There are also caves and underground aquifers in these areas. Groundwater aquifers are very vulnerable in karstic soils due to potential for polluting sources to sweep through and contaminate the groundwater. Counties with areas of karstified limestone are the coastal/estuarine areas of Galway, Mayo, Clare, Kerry, Limerick, Wicklow and Carlow

The most common types of soils that make up the landscape of Ireland are shallow brown earths, grey/ brown podzolic; acid brown earths; podzolic; gleys; and peats/ peaty gleys. These are described below and classified (Jones *et al*, 2014)

- Shallow brown earths are intra-zonal soil of temperate humid regions typically developed under deciduous forest into a dark rich layer (mull). These soils are present in parts of the following Counties Galway, Clare, Limerick, Tipperary, Kilkenny and Laois
- Acid Brown Earths: These soils are mature, well drained, mineral soils. They have not suffered from serious cases of leaching (loss of mineral). Top quality soil type, very desirable. With regular liming and fertilising the soils can be quite a productive soil. Areas with these types of soils include, East Limerick, South Tipperary, Waterford, Wexford and North East Cork.
- Gleys: a sticky waterlogged soil lacking in oxygen, typically grey to blue in colour. They develop from impermeable parent rock and suffer of excess run off from higher ground. It is a wetland soil that, unless drained, is saturated with groundwater for long enough periods to develop a characteristic gleyic colour pattern. These soils are of intermediate quality. Gley soils form on areas of rolling lowland or gentle sloping hillsides. These soils are present in the following counties: Clare, Limerick, Kerry, Cavan, Leitrim, Rosscommon.
- Grey-brown podzolic soil: a type of soil developed under deciduous forest in a temperate moist climate and characterised by a comparatively thin organic covering and an organic-mineral layer above grayish brown leached layer. Grey brown podzolic soils are top quality soil type and very desirable. The soils are extensively used for tillage. Areas with these types of soils are located in parts of the following counties, Dublin, Meath, some of the midlands, Galway, Tipperary, and Mayo.
- Podzolic soils are forested soils overlain on sandy deposits with a mean precipitation of 700mm. The most dominant vegetation type is the coniferous-dominated plant communities. If water logging or flooding occur, then little or no oxygen will be available and organic matter will eventually for an O horizon, which could result in the formation of peat and soil known as peaty podzol or peaty gleys. If the O horizon becomes deeper, than 30 cm, the soils becomes a blanket peat. These soils have a limited use range. It is confined to almost exclusively forest (conservation). If used for agriculture, it can suffer from severe leaching when overgrazed. These soils are present in the following counties: Cork, sections of Kilkenny, Tipperary, Meath, Westmeath and Longford.

Lands used predominately for tillage need free-draining soil of the south and east. The best soils for intensive livestock farming are limestone rich soils in lowland areas, which are found in the midlands and the south. The acid and peat soils of the western seaboard are most suitable for extensive hill farming and forestry (Creatmer *et al*, 2007). Calcareous limestone underlies large areas of the mid-lands, while acidic sandstones and shales are found in the south-west. Acid igneous rocks such a granite is found in the Wicklow mountains and the north and west are composed of metamorphic rocks such as gneiss, schist, and quartzite, which deliver beautiful landscapes such as Connemara, West Mayo and Donegal.

According to Gardiner and Radford (1980), Irish soil types could be associated with particular geology and landscape.

- Mountain landscape like those seen in the west of Ireland are made-up of shallow soils located on steep slopes (>500m); on less steep slopes, wet soils (groundwater and surface water gleys) and acidic soils are present. Peatland tends to occur on gently undulating landscapes.
- Hill Landscape (150-360m) developed from shale, sandstone, or occasionally granite. These soils are mainly acidic in nature and they include brown podzolics, brown earths and surface-water-gleys.
- Drumlin Landscapes developed after the most recent glacial advance. They are small oval-shaped hills that stand out as undulating landscape. The soil depends on the thickness of the glacial deposits but generally consists of luvisoils, brown earths, and brown podzolics.
- Flat undulating lowland landscapes are usually limestone dominated, with shallow soils and bedrock close to the surface. However, deeper soils tend to develop on glacial till that covers most of the limestone bedrock.
- Acidic lowland landscape: are underlain glacial deposits composed of sandstones and shales, or granite, or igneous rocks and metamorphic materials. These soils are more acidic than those above limestones. Acidic brown earths and brown podzolics.
- Alluvial Valley Landscape: are found in areas at the base of hills or mountains and on the floodplain and terrace of major rivers. Alluvial soils and peats are associated with these areas.

Arterial Drainage Maintenance Activities (2016-2021) will have no interaction with geology but can influence soils through sediment transport regime and land drainage. The reduction in the frequency of land flooding from drainage schemes and coastal embankments influences the sediment deposition and erosion regime on benefitting lands.

6.5.2 Threats to geology and soil

- Erosion and influence on land-use practices.
- Inappropriate land management practices, especially on more sensitive soil types could reduce water infiltration into the soil resulting in an increase of surface water runoff.
- Effect on hydromorphology (i.e. river channel and catchment flow and sediment regimes).
- Insensitive removal of vegetation during maintenance activities could increase the rate of erosion and sediment input to river channels, further increasing the rate of in-channel deposition and need for activity to maintain conveyance.

6.5.3 Opportunities for geology and soil

- Natural flood storage, attenuation and conveyance areas on floodplains including wetlands, should be considered in light of the impact on soil conditions and sediment regimes. Depending on the location maintenance activity could be of benefit or detriment to soil conditions.

6.5.4 Future Trends

Climatic conditions and rainfall shape landscape through weathering and erosion.

Projected climatic change could result in increased flooding which could pose a threat to soil conditions. Further research should focus on the potential impacts rainfall extremes with consequent threats of flooding on soil, as recommended in the STRIVE Report Series No.118 *Interactions of soil hydrology, land use and climate change and their impact on soil quality.*

6.6 Land-Use and Land-Cover

6.6.1 Introduction

The Irish Landscape has been shaped by hundreds of years of human intervention and land-use change. The overall area of artificial surfaces remains low in comparison with the rest of Europe and agriculture continues to be the dominant land use in Ireland.

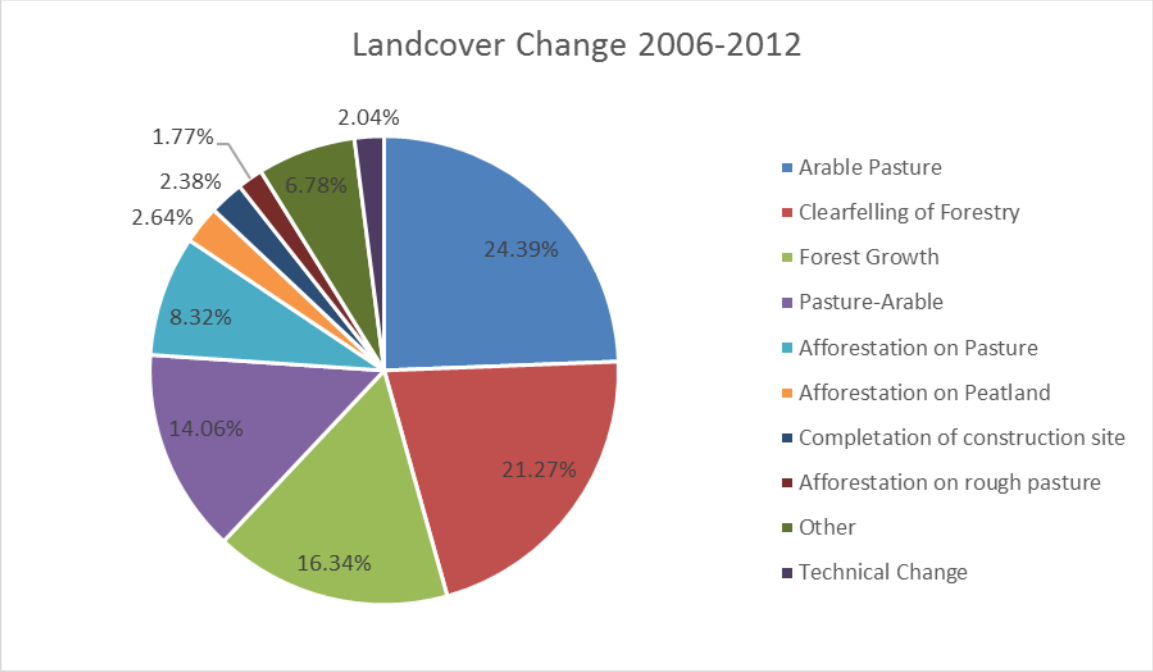
Land use and land cover (LULC) describe the form and function of the natural land surface. Land cover is the physical description of the land and land use describes the terrestrial use from a human perspective based on socio-economic usage (EPA, 2012b). In Ireland, the main source of LULC is the EPA and EEA CORINE (Co-Ordinated Information on the Environment) land cover data series, which have delivered maps in 1990, 2000, 2006, and 2012. Table 6-9 Summarises the percentage of land use cover and Figure 6-8 summarises land cover change in 2006 and 2011.

The main land cover type in Ireland is agriculture which accounts for two-thirds of the national landmass (CORINE, 2012). The majority of the agricultural land is permanent grassland pasture, followed by peatlands and wetlands, which cover one-fifth of the country, while forestry covers one-tenth of the country (CORINE, 2012). In spite of increased development in Ireland, the country's landscape is predominately rural and agricultural.

Table 6-9. Summary of existing 2006, revised 2006, and 2012 level 1 land cover statistics (Source: EPA, CORINE Info sheet 2012)

CORINE Level 1	Pre-Existing CLC 2006 % National Area	Revised CLC 2006 %National Area	CLC 2012 % National Are
Artificial Surface	2.29	2.45	2.49
Agricultural Areas	66.83	68.25	68.13
Forest and semi-natural areas	12.06	11.37	11.49
Wetlands	16.52	15.79	11.49
Water	2.29	2.14	2.14

Figure 6-8. Summary of 2006-2012 Land cover Change (Source: EPA, CORINE Infosheet, 2012)



Agriculture

Arterial Drainage Schemes were implemented in Ireland by the Office of Public Works (OPW) to bring long-term improvement to agricultural incomes in river catchments. The works were designed to allow landowners to install field drainage, which reduced waterlogging of land, allowing for more areas for livestock grazing or production of higher crop yields. The scheme has the effect of reducing the duration and in some cases, incidences of flooding. Depending on the type of soil and the nature of the flooding problems, some land may improve directly as a result of the drainage, however, in most cases, waterlogged land will only improve, if field drainage is installed. Projections of improvement due to Arterial Drainage estimated that approximately 88% of the target damaged land would be improved to the extent that it could carry extra livestock.

Agriculture continues to be the largest use of land in Ireland, with two thirds of the land devoted to it (CORINE, 2012). The land is primarily used for silage, rough grazing, or grass for pasture and it sustains various types of farming (dairy, meat, tillage). The Single Payment System (SPS), as part of the EU Common Agricultural Policy (CAP), places obligations on land managers to sustain good environmental conditions. For that reason, the Department of Agriculture, Food, and the Marine (DAFM) proposed the Rural Environmental Protection Schemes (REPS) for farmers to integrate environmental consideration with agricultural objectives in order to prevent negative impacts to the environment REPS is a scheme aimed to reward land managers for carrying out their farm management strategies in an environmentally sound manner and to attempt to improve the environment in the existing farms (DAFM, 2008). There have been various schemes in places, REPS, AEOS (Agri-Environment Options Scheme), and most recently GLAS (Green, Low Carbon, Agri-environmental Scheme). GLAS is the new agri-environmental scheme under the Rural Development Plan 2014-2020, which rewards farmers for carrying out environmentally sound practices that meet the criteria set out by the scheme. DAFM also promotes enhancement of farm management procedures and strategies, with production in mind, they proposed the Food Harvest 2020 Plan and Food Wise 2025. The guidelines suggest increasing productivity and primary output in the agriculture, fisheries, and forestry sector, enhancing market position, while also increasing export target (DAFF, 2010). Arterial Drainage Maintenance is not a direct element of Food Harvest 2020 or Food Wise 2025, as the focus of the plan is increase of productivity and more efficient agricultural practices; however, the upkeep of the channels from degradation (vegetation and silt accumulation, obstruction, bank slippage), is necessary to ensure the drainage scheme channels maintain their original design condition to facilitate the drainage purpose.

Siltation and nutrient loading are impacts of agricultural practices caused as a result of bank erosion, cattle access to streams, and losses from tillage land. Runoff of pesticides, fertilisers, and animal nutrients are threats to water quality from agriculture, especially with the presence of field drainages. In order to determine the interaction of agricultural land use with watercourses various receptors should be monitored: responses to rainfall, water quality (pesticides, fertilisers, animal nutrients), and sediment regime change.

Peatland

Although common in Ireland, peatlands are rare internationally and at the European scale. Deposition of peat occurred in post-glacial periods associated with the start of warmer and wetter climatic conditions. Peat is an unconsolidated brown and black organic material made-up of decomposed and undecomposed plant matter accumulated in a waterlogged environment. Peat characterises for having a high water content averaging over 90 percent by volume.

There are three main types of peat deposits:

- Blanket Bog - is composed of a carpet of flat, sloped, or undulating peat over a large area of land that is recharged by rainfall (in areas with >1,200 mm annually). The bog can be further divided into lowland blanket bogs (below 200mAOD) and mountain blanket bog (above 200mAOD). The soil tends to be acidic (approximate pH of 4.2) and can be 2m to 6m deep.
- Raised Bog - comprising dome shaped bogs that have developed in former lake basins (on top of fens) and recharged by rainfall (in areas with an annual rainfall between 800 to 900mm). The soil is acidic (pH 3.5).

- Calcareous and Alkaline Fens - Made-up of flat bogs that are found around lake margins and in water-logged areas where there is supply of mineral rich groundwater. They developed into raised bogs when the supply of mineral rich water is cut off. Soil is alkaline (approximate pH of 7 to 8) and can be around 2m deep.

Irish people have been closely connected to peatlands by a long history of cultural and economic developments. Turf cutting by locals for fuel is a valued tradition in Ireland. The extraction of peat became more important as the native forests were lost and generations of Irish families heavily relied on turf as the only source of heating. Over the years, peatlands became an important raw material which supported the livelihood of many rural communities. The conflict with turf cutting in a traditional sense arises when it conflicts with conservation and preservation of peatlands, as well as, the obligations and objectives of the State.

Currently, approximately one-fifth of land in Ireland is peatland, including raised bogs, blanket bogs, and fens. Peatlands are valuable ecosystems with rich flora and fauna, as well as, they provide valuable ecosystem services such as value for biodiversity, regulation of climate change, flood attenuation, water infiltration and supply, and important supply for human welfare. In addition, peatlands also provide a unique landscape which can be used for amenity activities for locals, visitors, or tourists. The degradation, damage, and inappropriate management of peatland has resulted in additional costs from increased flooding of properties and land, damage to rivers and lakes, losses in fisheries due to decreased fish spawning or nursery grounds, increased cost of water treatment and increased emissions (NPWS, 2015). Natural peatlands act as long-term carbon storage, however, when peatland is cut, carbon dioxide (CO_2) and other greenhouse gases are released into the atmosphere. In addition, damage to peatland impacts on water quality due to silt release from mechanical peatland harvesting, increases nutrient loading from drained bogs and acidification from afforestation on bogs. NPWS Article 17 Report states that several peatland habitats remain in bad status with predicted ongoing declines. The assessment suggests that drainage has the biggest impact on peatlands followed by burning, and cutting and suggests that the integrity of peatlands is dependent on land management practices (NPWS, 2013).

The EPA Strive-funded peatland study on sustainable management of peatland in Ireland determined that up to 95% of all peatland exists in a degraded state (EPA STRIVE, 2007-2013). For that reason, various governmental and non-governmental organisations, and institutions (i.e. universities) joined in partnership to develop various approaches to conserve Irish peatlands. National Parks and Wildlife Services (NPWS) has been leading the preparation of the National Peatland Strategy (2015), the Draft Raised Bog Special Area of Conservation (SAC) Management Plan and a Draft Raised Bog Natural Heritage Areas (NHAs) Review.

Arterial Drainage Maintenance Activities (2016-2021) aim to maintain the schemes (channels, embankments, flood relief schemes) to its intended original design conditions. The maintenance activities include the removal of obstructions, excess silt and vegetation, and repairing bank damage or slippage. Although the direct impacts are not assumed to be significant, some maintenance activities may impact on the hydrology of peatland. These could result in the lowering of the local water table which can have detrimental effects lead to the drying out of the uppermost peat, the increase of temperature, higher oxygen levels, and hence increased decomposition rate within surface peat.

Wetlands

Wetlands cover around 15% of the surface area of Ireland. The majority of this land cover is comprised of over 12,000 lakes.

Wetland is a collective term for ecosystems (habitats and their associated species) whose formation has been dominated by water, and whose processes and characteristics are largely controlled by water. They occur where the water table is at or near the surface of the land, or where the land is covered by s layer of shallow water, for some or all of the year.

The 1971 Ramsar Convention on Wetlands of International importance defines wetlands[3] as:

“areas of marsh, fen, peatlands or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters”.

[3] An Introduction to the Convention on Wetlands (previously The Ramsar Convention Manual). Ramsar Convention Secretariat, Gland, Switzerland.

Ireland is a signatory of the Ramsar Convention where it is committed to protecting coherent sites, Article 2.1 of the Ramsar Convention provides that wetland sites may:

"Incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands"[4].

The five major wetland sites usually recognised are:

- Marine: Coastal wetlands including coastal lagoons, rocky shores, and coral reefs
- Estuarine: including deltas, tidal marshes, and mangrove swamps.
- Lacustrine: wetlands associated with lakes
- Riverine: wetlands along rivers and streams;
- Palustrine: marshy-wet grassland, marshes, swamps and bogs.

These wetlands provide a significant habitat for migratory birds and form significant landscape features.

In addition to naturally occurring wetlands produced as a result of natural environmental processes, there are artificial wetlands such as fish ponds, farm ponds, irrigated agricultural land, reservoirs, gravel pits, sewage treatment facilities, and drainage ditches.

In contrast to other habitat types, wetlands are often young, dynamic ecosystems, changing in a relatively short period of time as vegetation changes, sediments are laid down and local hydrological conditions are altered. Wetland are often composed of a mosaic of habitats such as small areas of fen and bog communities, pools, drainage ditches, and ever deeper pools or small lakes.

The west of Ireland is one of the few locations globally where turloughs are also present. Turloughs are topographic depressions in geologically karst regions that are intermittently inundated on an annual basis, mainly from groundwater, that drain without overland stream outflow, and that have a substrate and/or ecological communities that are characteristic of wetlands (NPWS, 2015[5]). Turloughs have been subject to drainage and agricultural intensification and many are degraded. The continued maintenance of drainage channels has the potential to continue to degrade the status and condition of turloughs.

Forestry

Forestry in Ireland accounts for 9.2% of the land cover (EPA, 2012b and CORINE, 2012). The forests in Ireland are young, with approximately 40% planted since 1990. However, about 75% of these forested areas are coniferous, mainly of commercial timber species. The Rural Development Programme 2007-2013 set a target of 30% annual broadleaf afforestation, which was accomplished primarily through the reduced plantation of coniferous trees. The appropriate management of forest land is crucial to mitigate environmental impacts, while maintaining their commercial requirements. The period between 2006 and 2012 experienced the largest land cover change with afforestation on agricultural land and peatland having the biggest influence. The DAFM prepared a Draft National Forestry Programme and a National Policy Review to promote better forest management practices around Ireland.

Arterial Drainage Maintenance Activities can maintain the productivity and soil conditions of forestry land close to drainage channels. Maintenance of embankments preserves the level of flood protection offered to some commercial forestry land. Embankments may also impact on the natural drainage of forestry lands.

Artificial surface and Benefiting Lands

Artificial surfaces account for 2% of the land surface, which is half the Europe wide average of 4% (EPA, 2012b).

Lands identified as being liable to flooding are categorised as "benefiting lands". Benefiting lands are defined by the Office of Public Works (OPW) identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage. The Arterial drainage scheme and

[4] An Introduction to the Convention on Wetlands (previously The Ramsar Convention Manual). Ramsar Convention Secretariat, Gland, Switzerland.

[5] Waldren, S. 2015, Ed. Turlough Hydrology, Ecology and Conservation. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

drainage districts facilitated the improvement of extensive areas of agricultural land, through the drainage of flooded land. The Arterial Drainage Maintenance Activities ensure that the channels remain in a good condition, which ensure that the productivity of these agricultural lands and social benefits continue to be exhibited. If arterial drainage schemes, embankments and flood relief schemes fall into disrepair there is the potential for claims for financial losses from landowners within benefitting lands.

Much of the artificial surface within benefitting lands is associated with disperse rural settlement and agricultural developments.

6.6.2 Threats to land use and land cover

- The extent and intensity of land drainage in both the uplands and lowlands could have an impact on the regime of the waterways, and increase flood risk.
- Inappropriate land management practices, especially on more sensitive soil types could reduce water infiltration into the soil resulting in an increase of surface water runoff.
- The management of grassland, semi-natural vegetation, wetlands, and woodlands can assist in the storage of rapid surface runoff and floodplain flows upstream of flood risk receptors.
- Inappropriate or intensive land-use practices can result in erosion, modification of channel geomorphology, or discharge of receiving sediments.

6.6.3 Opportunities for land-use and land-cover

- Natural flood storage areas on flood plains including wetlands should be protected from development pressures**.**
- The potential for maintenance activity to ensure sustainability of land-use through the maintenance of an FRS for sustainability of flood risk and maintenance of channels for agricultural productivity.
- Consideration of maintenance activities for land-use planning.

6.6.4 Summary Table

The summary table below (Table 6-10) displayed a catchment-wide assessment of land-use/land-cover in Ireland, as well as, highlights the relevant OPW Schemes present in each catchment.

6.6.5 Future Trend

It is unlikely that the land use in Ireland will substantially change in the short to medium term. Agriculture will continue to be the dominant land-use, with the more intensive arable production continuing to be restricted to better quality soils.

The Food Harvest 2020 and Food Wise 2025 agricultural strategy put forward in 2010 by the Department of Agriculture sets out a range of objectives for the entire agricultural sector for the next decade. The aim of the plan is to achieve a competitive critical mass in the international marketplace and target consumers who value 'green output'. Although the strategy provides some environmentally sound advice in terms of technology, it also promotes increased productivity and quotas which can counter the environmental schemes (REPs, AEOS, GLAS). Agriculture is considered to be responsible for 32.1% (one-third) of Ireland's total climate emissions and it is important that sustainable agricultural practices continued to be promoted and practiced.

Agriculture plays a significant role in Ireland's economy and the adaptation of the Harvest 2020 and Food Wise 2025 has strengthened Ireland's vision of producing more 'green' food and dairy products. The development of an environmentally friendly production that delivers sustainable export, is the future projection of these plans. Food Harvest 2020 and Food Wise 2025 have placed ambitious targets on food exports over the coming years. There is an increased mandate for agricultural production, which will result in a higher demand for productive agricultural land. Although marginal land may be of less agricultural values, it could provide many ecosystems services that could help mitigate impacts of agricultural intensification such as habitat linkages/corridors, flood relief attenuation, buffer areas for the capture of runoff from poor land

use. The OPW's Arterial Programme will help to ensure that flooding on agricultural land (both productive and marginal) is minimised.

Forest management practices particularly afforestation have potential to provide environmental and economic benefits if managed sensibly. Potential impacts of afforestation on water quality should be included in forestry schemes such as the Afforestation Scheme, the Forest Environmental Protection Scheme (FEPS), and the Native Woodland Scheme (Forest Service, 2011a, b. c).

Peatland and wetland areas are of important environmental and ecological importance, the protection and appropriate management of these are crucial for their short-term and long-term conservation (See 6.7. Flora and Fauna). The implementation of actions arising from the National Peatlands Strategy will have some impact upon the nature of arterial drainage maintenance activity.

Table 6-10. Catchment-wide assessment of land-use/land cover using the CORINE 2012 dataset.

Catchment Name	Catchment Area (km2)	Area of Benefitting Lands (km2)	% agriculture	% woodland/ forest/ Shrub	% peatland	% waterbody	% Man Made	OPW Scheme
Ballyteigue-Bannow	660.05	7.6	70	10	5	10	5	Ballyteigue/Kilmore
Bandon-Ilen	1799.54	0.2	70	10	5	10	5	Bandon River (Dunmanway)
Barrow	3015.7	0	50	25	10	5	10	Kildare
Blacksod-Broadhaven	1298.4	0	10	30	50	9	1	
Blackwater (Munster)	3307.64	0	60	20	10	0	10	Mallow
Boyne	2689.69	57.2	50	10	15	5	20	Boyne and Mprnington
Colligan-Mahon	661.91	4.2	60	20	10	5	5	Brickey
Corrib	3113.28	41.0	50	5	10	30	5	Corrib
Donagh- Moville	511.69	0	40	15	30	5	10	
Donegal Bay North	805.36	0	30	15	25	20	10	
Dunmanus-Bantry-Kenmare	1900.44	2.0	15	15	65	1	4	Ouvane
Erne	3440.52	14.2	60	10	10	10	10	Abbey, Duff and Kilcoo
Erriff-Clew Bay	1509.18	0.6	20	10	50	15	5	
Foyle	1105.9	16.1	50	20	25	0	5	Donegal
Galway Bay North	1019.56	0	5	15	70	9	1	
Galway Bay South East	1267.9	0	55	15	5	20	5	Gort and Lackan
Gweebarra-Sheephaven	1453.7	0	10	20	55	10	5	
Laune-Maine-Dingle Bay	2036.75	47.7	30	10	45	10	5	Maine
Lee, Cork Harbour and Youghal Bay	2181.8	0	65	5	5	5	20	Cork Embaankment Scheme (Fermoy
Liffey and Dublin Bay	1624.42	0.6	40	10	15	5	30	Ryewater and Hazelhatch (Shinkeen), Leixlip (Kildare)
Lough Neagh + Lower Bann	551.21	36.9	70	10	15	1	4	Monaghan Blackwater
Lough Swilly	960.76	0.1	30	15	25	20	10	Donegal (Bridge End)

Catchment Name	Catchment Area (km2)	Area of Benefitting Lands (km2)	% agriculture	% woodland/ forest/ Shrub	% peatland	% waterbody	% Man Made	OPW Scheme
Lower Shannon (A)	1248.46	36.9	55	10	30	5	10	Brosna, Tullamore
Lower Shannon (B)	982.87	0	40	20	20	10	10	
Lower Shannon (C)	1820.51	95.1	40	20	10	25	5	Clareen, Nenagh, Woodford, Killmor and Carrigahorig
Lower Shannon (D)	1041.27	76.3	55	15	10	10	10	Groody, Mulkear, Ballymackeogh, Mulkear Cappamore
Mal Bay	846.56	3.8	40	20	20	15	5	Creegh and Cloghauninchy
Moy+ Killala Bay	2353.09	28.9	60	5	20	10	5	Moy
Nanny-Delvin	708.22	35.2	75	2	0	5	18	Duleek (Nanny), Matt, Broadmedow and Ward
Newry, Fane, Glyde and Dee	1675.31	12.4	60	9	11	5	15	Glyde and Dee
Nore	2585.49	0	60	10	15	5	10	Kilekenny
Ovoca-Vartry	1234.2	0	20	25	30	10	15	
Owenavorragh	394.7	9.9	80	5	0	5	10	Owenavorragh
Shannon Estuary North	1651.28	44.4	45	20	10	15	10	Shannon Embankment North (Clare, Ennis, and Fergus), Sixmilebridge (Owenagarney),
Shannon Estuary South	2037.74	24.7	80	3	2	10	5	Deel, Maigue, Shannon Embankment South (Limerick), Maigge outfall,
Slaney + Wexford Harbour	1980.05	0	60	10	15	5	10	
Sligo Bay + Drowse	1605.56	15.0	40	15	20	20	5	Bonet
Suir	3552.54	0	50	15	20	5	10	Carrick-on-Suir, Clonmel
Tralee Bay-Feale	1780.08	10.3	40	30	20	5	5	Feale
Upper Shannon (A)	604.47	0	50	10	30	9	1	
Upper Shannon (B)	674.14	72.4	40	20	20	25	5	Boyle

Catchment Name	Catchment Area (km2)	Area of Benefitting Lands (km2)	% agriculture	% woodland/ forest/ Shrub	% peatland	% waterbody	% Man Made	OPW Scheme
Upper Shannon (C)	1500.15	0	70	8	16	5	1	
Upper Shannon (D)	1598.07	0	40	20	25	5	10	
Upper Shannon (E)	581.91	9.6	30	10	5	50	5	Ballyglass (Knockcroghery)
Upper Shannon (F)	1229.12	25.7	60	5	20	10	5	Inny
Upper Shannon (G)	383.02	0	40	2	30	20	8	

6.7 Flora and Fauna

6.7.1 Introduction

Ireland is committed on a national and international level to protect biodiversity. It comprises a variety of terrestrial, wetland, freshwater, estuarine, and coastal habitats that support a range of species. Ireland's wetland and aquatic systems sustain internationally significant populations of birds, fish, and invertebrates, as well as, supporting seabird breeding colonies, cold-water coral communities, among many other valuable species. National Parks and Wildlife Services (NPWS) estimates that Ireland is home to 28 species of land mammal, over 400 species of birds, more than 4,000 plant species and over 12,000 species of insects (NPWS. 2016).

Ireland is required under the terms of the EU Birds Directive (2009/147/EC) to designate Special Protection Areas (SPAs) for the protection and conservation of endangered species of wild birds. 140 of Ireland's 154 SPA sites have been protected by Statutory Instruments (NPWS, 2016). The Statutory Instrument is the last step in the designation process, however, all SPAs are considered protected from their date of classification (NPWS, 2016). Special Areas of Conservation (SAC) are main wildlife areas in Ireland, considered to be of significant importance in a National and European Level. The Habitats Directive (Council Directive 92/43/EEC) was adopted in 1992 with the aim of protecting wild fauna and flora, as well as its habitat. In Ireland, the directive was transposed and amended in 1998 and 2005. The Irish habitats include raised bogs, blanket bogs, turloughs, sand dunes, machair, heaths, lakes, rivers, woodlands, estuaries, and sea inlets. There are 25 Irish species protected, these include Otter, Salmon, Freshwater Pearl Mussel, Bottlenose Dolphin, and Killarney Fern. There are 424 SACs areas around Ireland. SPAs and SACs make-up the Natura 2000 network.

The most basic designation for wildlife is Natural Heritage Area (NHA) given to areas considered important habitats or which hold species of plants and animals whose habitat require protection. Seventy-five raised bogs and 73 blanket bogs have received legal protection. In addition, there are approximately 630 Proposed NHAs (pNHAs), which were published on a non-statutory basis in 1995 but have not since statutorily proposed or designated (NPWS, 2016). Prior to designation pNHA receive limited protection. Under the Wildlife Amendment Act (2000), NHAs are legally protected from damage from the date they are formally proposed for designation.

The Wildlife Act 1976 (as amended 2000) is the principle mechanism for the legislative protection of wildlife in Ireland. It outlines strict protection for species that have significant conservation value. The Act protects species from injury, disturbance and damage to breeding and resting areas. All the species protected under the Act must be subject to material consideration in the planning process. The Flora Protection Order 1999 makes it illegal to cut, uproot, or damage listed plant species in any way.

Unfortunately, Ireland's most important habitats are reported to be in poor or bad conservation status, especially raised and blanket bogs, dune systems, oligotrophic lakes, fens and mires, natural grassland, and woodlands. It is believed that a mere 9 percent of habitats listed under the Habitat's Directive have been found to be in a favourable position. Species are doing better in conservation terms, as approximately 52 percent of the listed species are in a favourable state. However, NPWS have identified some species in their Red List of species in need of conservation intervention, these include: Irish bee species, non-marine mollusc, Irish water beetle, damselflies, dragonflies, and butterfly species. From the 199 bird species assessed in the population status of Ireland's birds (2007-2011), 25 were placed on the red list, including the kestrel and skylark.

The Arterial Drainage Schemes have been constructed throughout Ireland and the majority of the channels are located in close proximity or within SAC and SPA sites. There are approximately 6,000km of Arterial Drainage channels that cross through an SAC or are located within an SAC and around 3,000km of Arterial Drainage Channels that overlap with an SPA.

There are 19 Marine Protected Areas (MPA) under the OSPAR Convention in Irish waters. Arterial drainage scheme channels and the embankments have the potential to influence flow rates and the concentration of pollutants discharging to MPAs. All designated nature conservation sites in Ireland are listed in the table below (Table 6-11).

Table 6-11. Summary of Designated Nature Conservation Sites in Ireland

Site	Legislation	Number in Ireland
Special Area of Conservation	European Communities (Natural Habitats) Regulations, 1997 (as amended) and consolidated by the European Communities (Birds and Natural Habitats) Regulations 2011	~424
Special Protection Area	European Communities (Natural Habitats) Regulations, 1997 (as amended) and consolidated by the European Communities (Birds and Natural Habitats) Regulations 2011	~154
Ramsar Site	The Convention on Wetlands of International Importance especially as Waterfowl Habitat (i.e. the Ramsar Convention)	~25
Natural Heritage Area	Wildlife (Amendment) Act, 2000	~148
Proposed Natural Heritage Area	Wildlife (Amendment) Act, 2000	~630
Nature Reserve	Wildlife Act, 1976 and the Wildlife (Amendment) Act, 2000	~75
Wildfowl Sanctuaries	Wildlife Act, 1976 and the Wildlife (Amendment) Act, 2000	~68
OPSAR Marine Protected Areas	No relevant legislation	~19

The sections below present habitats and species that are likely to be present in the vicinity of National Arterial Drainage Maintenance Activities (2016-2021).

6.7.1.1 Fisheries

There are various species commonly found in freshwater and estuarine environments which include but are not limited to Eel (*Anguilla anguilla*), Lamprey (*Petromyzon marinus, Lampetra fluviatilis*, *Lampetra planeri)* Atlantic Salmon (*Salmo salar*), Brown Trout *(Salmo trutta),* Bass (*Dicentrachus labrax*)**,** Stone Loach (*Barbatula barbatula*), Minnow (*Phoxinus phoxinus*), Three Spined Stickleback (*Gasterosteus aculeatus*), and Gudgeon *(Gobio gobio)* in freshwater and Arctic Charr (*Salvelinus alpinus*), Shad (*Alosa alosa* and *Alosa fallax*), Pollan (*Coregonus autumnalis*) in estuaries. Many of these species are present within Arterial Drainage Schemes. The species described below are frequently found in OPW channels.

Lamprey

Three species of Lamprey exist in Irish waters: sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), and brook lamprey (*Lampetra planeri*). Brook lamprey is an entirely freshwater species, while the other two species, spend most of their adult life in the sea, but migrate upstream into freshwater systems to spawn.

Legislation for the protection of lamprey was introduced by the European Union through the Directive on the Conservation of Natural Habitats and Wild Fauna and Flora (92/43/EEC). Ireland had to set aside Special Areas of Conservation (SAC) for the three species of lamprey found in Ireland. The objective of SACs in regards to lamprey is to ensure 'the maintenance or restoration, at a favourable conservation status of lamprey populations'. In order for freshwater sites to support lamprey populations, they must be characterised by good water quality, clean sediments at spawning grounds, and the presence of stable sandy silt beds (Kurz and Costello, 1999). In order to conserve lamprey, the known spawning grounds need protection and maintenance, as well as lamprey requiring unhindered access to upstream spawning grounds during migration (Kurz and Costello, 1999). Lamprey species are listed as a qualifying interest of 14 SACs, and from these, ten are located near or within a maintained OPW channel (Table 6-12). Therefore, any changes in the drainage patterns of relevant river catchments of the Arterial Drainage Programme require careful control and should preserve good water quality.

Table 6-12. Designated sites with qualifying interest (Lamprey) and presence or absence of OPW drainage work

Site Code	Site Name	Species	Intersected by OPW Channels
000297	Lough Corrib	*Petromyzon marinus* *Lampetra planeri*	Yes
000343	Castlemaine Harbour	Petromyzon marinus *Lampetra fluviatilis*	Yes
000365	Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment	*Petromyzon marinus* *Lampetra planeri* *Lampetra fluviatilis*	No
000458	Killala Bay / Moy Estuary	*Petromyzon marinus*	Yes
000627	Cummeen Strand/ Drumcliff Bay (Sligo Bay)	*Petromyzon marinus* *Lampetra fluviatili*	No
000781	Slaney River Valley	*Lampetra fluviatilis* *Lampetra planeri* *Petromyzon marinus*	No
001976	Lough Gill	*Petromyzon marinus* *Lampetra planeri* *Lampetra fluviatilis*	Yes
002137	Lower River Suir	*Petromyzon marinus* *Lampetra planeri* *Lampetra fluviatilis*	Yes
002162	River Barrow and River Nore	*Petromyzon marinus* *Lampetra planeri* *Lampetra fluvuatilis*	Yes
002165	Lower River Shannon	*Lampetra fluviatis* *Lampetra planeri* *Petromyzon marinus*	Yes
002170	Blackwater River (Cork/Waterford)	*Petromyzon marinus* *Lampetra planeri* *Lampetra fluviatilis*	No
002171	Bandon River	*Lampetra Planeri*	Yes
002298	River Moy	*Petromyzon marinus* *Lampetra planeri*	Yes
002299	River Boyne and River Blackwater	*Lampetra fluvuatilis*	Yes

Atlantic Salmon

Wild Salmon in Ireland are part of our national identity and Ireland has been one of the largest producers of wild salmon in the North Atlantic. Ireland traditionally operated a commercial offshore fishery, an estuarine drift net fishery and in-river angling. Due to the declining number of salmon returning to the Irish Coast, conservation initiatives were introduced to address the decline in stock.

Salmon is now managed on a river by river basis, as opposed to a national or district level. Rivers that have an excess of 65% of the conservation limit are granted catch and release status subject to approval. Rivers that have insufficient scientific information or have a rod catch of less than 10 salmon remain closed.

Conservation limits have been set for the 148 Irish Salmon Rivers and recreational and commercial inshore fisheries are now regulated relative to these conservation limits being met on a river by river basis. The standing Scientific Committee (SSC) of Inland Fisheries Ireland (IFI) reviews all data for salmon rivers to provide scientific advice on the compliance levels (i.e. CL attainment levels).

Wild Salmon and Sea Trout Tagging Schemes regulate salmon and sea trout fishing in Ireland and is administered by Inland Fisheries Ireland (IFI). Anglers are prohibited from selling salmon (any size) or sea trout (any size) caught by rod and line. The protected areas of salmonid species are listed in the Salmonid Regulations (S.I 293/1988), which designate 'waters capable of supporting salmon (Salmo *salar*), trout (Salmo *trutta*), charr (*Salvelinus sp.*) and whitefish (*Coregonus sp.*) as protected. The Habitat Regulations (S.I 94/1997) separately protect the habitats of Atlantic Salmon only. The standard parameters used to assess the quality of (salmonid waters) include temperature (°C), pH, dissolved oxygen (mg/litre O_2), suspended solids (mg/litre), nitrites (mg/litre NO_2) among others. There are 12 designated salmonid waters overlapping with OPW Scheme Channels, 11 rivers and one lake, as displayed in Table 6-13.

Salmon inhabit extents outside these areas and may use habitat in close proximity to other OPW channels.

Table 6-13. Salmonid Designated Waterbodies with OPW Schemes (Source. OPW, 2011)

Salmonid Waterbody	OPW Scheme
River Boyne	Boyne
River Maine	Maine
River Corrib	Corrib Clare
Lough Corrib	Corrib Clare, Corrib Headford
River Swilly	Swilly Embankments
River Moy	Moy
Corry	Moy
Owengarve	Moy
Glore	Moy
Mullaghanoe	Moy
Spaddagh	Moy
Gweestion	Moy
Manulla	Moy
Castlebar	Moy
Deel River	Moy
Trimoge River	Moy
Yellow River	Moy
Nore River	Kilkenny FRS
Feale River	Feale

6.7.1.2 Shellfish

Freshwater Pearl Mussel

Fresh Water Pearl Mussel (FPM) have a wide geographical distribution in Ireland, particularly in the South West, South East, West and North West of the country. The population type ranges significantly, from a small community with a few elderly mussels that have not recruited successfully, to some of the largest pearl mussel populations in the world. There are 96 populations of pearl mussels in the Republic of Ireland, some which include two or more rivers in proximity to them one single population (Moorkens *et al*., 2007). However, only 27 populations (26 for *M. margaritifera* and 1 for *M. durrovensis*) have been designated within 19 SACs areas for *Margaritifera margaritifera*.

During the reporting period of 2007-2012 carried out by NPWS, it was concluded that from the 96 Irish FPM populations, none were viable and all the FPM populations were found to be in an unfavourable bad condition based on a combination of population viability and population decline (NPWS, 2013). The monitoring results displayed that reproduction and juvenile survival did not meet adult mortality and population numbers were significantly declining (NPWS, 2013). Various factors contributed to the result: the decline in water quality due to nutrient enrichment, pollution incidents, river bank erosion, forest plantation, road building, bog drainage, arterial drainage schemes, river modification, and over-grazing (NPWS, 2013). The FPM need an environment with well-oxygenated water, low in minerals and nutrients, a clean riverbed, included well oxygenated gravel and sand substrate (Moorken,1999).

The FPM Sub-basin Management Plan for waters designated for protection under the European Communities (Fresh Water Pearl Mussel) Regulation 2009 S.I 296 of 2009 were developed to provide a programme with measures to improve the habitat for FPM. These plans identify pressures and threats within a catchment and provide catchment specific measures for the management of FPM. Catchments may be designated even if FPM is not distributed through the whole catchment. Areas surrounding the river catchment are considered to be *Margaritifera* sensitive areas and should be recognised and protected from contributing to the degradation of water quality. The rivers listed below are protected for conservation of Irish FPM under the FPM Regulations 2009 (Table 6-14).

Table 6-14. Waters protected for conservation of Irish Fresh Water Pearl Mussel (*Margaritifera Margaritifera*)

Water designated for protection of Fresh Water Pearl Mussel			
Bandon	Owenriff (Corrib)	Leanna	Owenea
Aughavaud (Barrow)	Currane	Allow (Munster Blackwater)	Owenmore
Ballymurphy (Barrow)	Dawros	Licky	Ownagappul
Mountain (Barrow)	Eske	Munster Blackwater	Cloon (Shannon Estuary)
Bundorragha	Kerry Blackwater	Newport	Derreen (Slaney
Caragh	Gearhameen (Laune)	Nore	Clodiagh (Suir)
Clady	Glaskeelan (Leannan)	Owencarrow	

The OPW channels listed in Table 6-15have been identified as containing FPM. The potential impacts of any works proposed within the zone of influence of these channels will have to be assessed prior to the commencement of the proposed works, in consultation with NPWS.

Table 6-15. OPW Channels identified as containing FPM

Channel	Scheme	Location	Most Recent Record
CH9	Corrib Headford	Oughterard	2009
C1/21/3	Moy	Approx 500yards from outfall to into L.Cullin	2004
C1 Sect M &N	Moy	Ballygallagart	2004
C1/21/14	Moy	Crossmolina	2008
C1	Dunmanway FRS	d/s of the Long Bridge	2003
C1	Owvanme	Approx 1400 yards from outfall	2002
C1	Feale	d/s Listowel near Scartleigh cementary	2006
**Owenaher	Moy	u/s of C1/54	1996
**Brown Flesk River	Maine	Trib of C1 Maine near Farranfore	1987
** Galey River	Feale	Approx 1400 yards u/s of C1/18 near Ahavoher Br.	1950
** River Liffey	Ryewater	(Lucan) Approximately 3.5 d/s C1 Ryewater outfall	1894
** Although not on OPW channels- these channels may or may not contain populations of FPM. Works in vicinity which could impact on a possible population need to be considered in close consultation with local FPM knowledge. **			

Since 2007, the FPM population has experienced an 8% decrease. As the consenting authority for forestry activities, the Department of Agriculture, Food, & the Marine (DAFM) through the forest services (FS-DAFM) were under direct responsibility to help protect FPM and its habitat. Through these responsibilities and as part of the national strategy for the conservation of FPM developed by NPWS, the FS-DAFM Plan for *Forestry and Freshwater Pearl Mussel in Ireland* is being developed. The proposed plan will contain a forestry management framework and accompanying measures for the priority 8 FPM catchments, as well as the assurance that all forestry consent and approvals**,** and to recognise the role of woodlands and forests in the protection and enhanc**e**ment of water quality for FPM. The plan is in the Appropriate Assessment Screening stage (published February 2016) (DAFM, 2016).

White-clawed Crayfish

White-clawed crayfish (*Austropotamobius pallipes*) are protected under Annex II of the EU Habitat Directives. These species are believed to be dispersed around central Ireland. Various OPW channels are believed to contain crayfish, as the species are known to inhabit a range of drainage channels in many catchment areas, nationwide. The following SACs have white-clawed crayfish as a qualifying interest and also are intersected by channels maintained by the OPW (Table 6-16).

Table 6-16. Designated sites with qualifying interest (White-clawed Crayfish) and presence of OPW drainage work

Site Code	Site Name	Intersected by OPW Channels
000297	Lough Corrib	Yes
000688	Lough Owel	Yes
001976	Lough Gill	Yes
002120	Lough Bane and Lough Glass	Yes
002298	River Moy	Yes
001810	White Lough, Ben Lough, & Lough Doo	Yes
002121	Lough Lene	Yes
002137	Lower River Suir	Yes
002162	River Barrow and River Nore	Yes

6.7.1.3 Mammals

The geographic scale covered by mammals in Ireland is wide and many of these intercept with Arterial Drainage Schemes/Channel/Embankments. Some of these species are protected under Annex II and/or Annex IV of the EU Habitats Directive and the 1976 Wildlife Act (amended 2000) such as Hedgehog (*Erinaceus europaeus*), Phygmy Shrew (*Sorex minutus*), Irish and brown hare (*Lepus timidus* and *Lepus euroaeus*) red squirrel (*Sciurus vulgaris*), Stoat (*Mustela erminea*), and various species of bats and deer. Some of the common mammal species are described in more detail below.

Otters

Ireland is considered to have one of the most important otter (*Lutra lutra*) populations remaining in Western Europe (Whilde 1993). Surveys carried out in the early 1980's (Chapman and Chapman 1982) and in the early 1990's (Lunnon and Reynolds 1991) confirmed that the species was widespread throughout the country in freshwater and coastal habitats (Bailey and Rochford 2006). Due to the various threats to the species from habitat loss, disturbance and pollution, the otter was included on the Annex II and Annex IV of the EU Habitats Directive (Council of European Communities (CEC) 1992), Appendix II of the Berne Convention and in the Red-data book listed as Vulnerable (Whilde 1993) (Council of Europe 1979). Climate change could have both a direct or indirect effect on European otter populations. There is evidence that climate change will impact otter species distribution, resulting in species possibly moving out of a conservation area (Hannah, et al. 2007).

The NBDC has compiled otter records from various studies such as the Otter Survey Ireland (1982), Otter Survey of Ireland (2004 and 2005) Atlas of Mammas in Ireland (2010-2015) among others.

Badgers and Pine Marten

The Eurasian Badger (*Meles meles*) and Pine Marten (*Martes martes*) are two of Ireland's most common large mammal (Smal 1995). They are both protected under the 1976 Wildlife Act (amended 2000) and the IUCN Threatened Species Red List. They have been considered a pest due to its wide spread distribution, especially in regards to game and domestic fowl. The NBDC has compiled badger and pine marten records from various studies and databases such as the Irish National Badger Sett Database, Atlas of Mammals in Ireland (2010-2015), Road Kill Survey, among others.

Bats

There are nine species of bats confirmed in Ireland (Roche et al. 2014). These belong to two families; eight species belong to the family *Vespertilionidae* and one in the *Rhinolophidae* family as displayed in table below (Table 6-17). All bats are protected under the Wildlife Act 1976 and the EU Habitats Directive (92/43/EEC). The Lesser horseshoe bat (*Rhinolophus hipposideros*) which is found in the Republic of Ireland is only listed in Annex II of the EU Habitats Directive, while all bat species are in Annex IV of the same Directive.

Table 6-17. Bat species in confirmed in Ireland

Family Name	*Vespertilionidae*	*Rhinolphidae*
Species Name	Natterer's bat (*Myotis nattereri*)	Lesser horseshoe bat (*Rhinolophus hipposideros*)
	Soprano pipistrelle (*Pipistrellus pygmaeus*)	
	Nathusius' pipistrelle (*Pipistrellus nathusii*)	
	Common pipistrelle (*Pipistrellus pipistrellus*)	
	Leisler's bat (*Nyctalus leisleri*)	
	Brown long-eared bat (*Plecotus auritus*)	
	Daubenton's bat (*Myotis daubentonii*)	
	Whiskered bat (*Myotis mystacinus*)	

6.7.1.4 Habitats

Habitats are basic building blocks of the environment that are inhabited by animals and plants, and which are important units for site description and conservation management (Fossitt 2000). Wildlife habitats in Ireland cover natural, semi-natural, and artificial habitats of terrestrial, surface water and ground water dependent habitats within freshwater environments, or inshore marine waters and of urban and rural areas. Arterial drainage Schemes/Embankments/Flood Relief Schemes are associated with linear channels of freshwater which move or transport water and various habitats adjacent to it may be influenced directly or indirectly by the channel/embankment such as riparian woodland and/or vegetation, peatlands and forests.

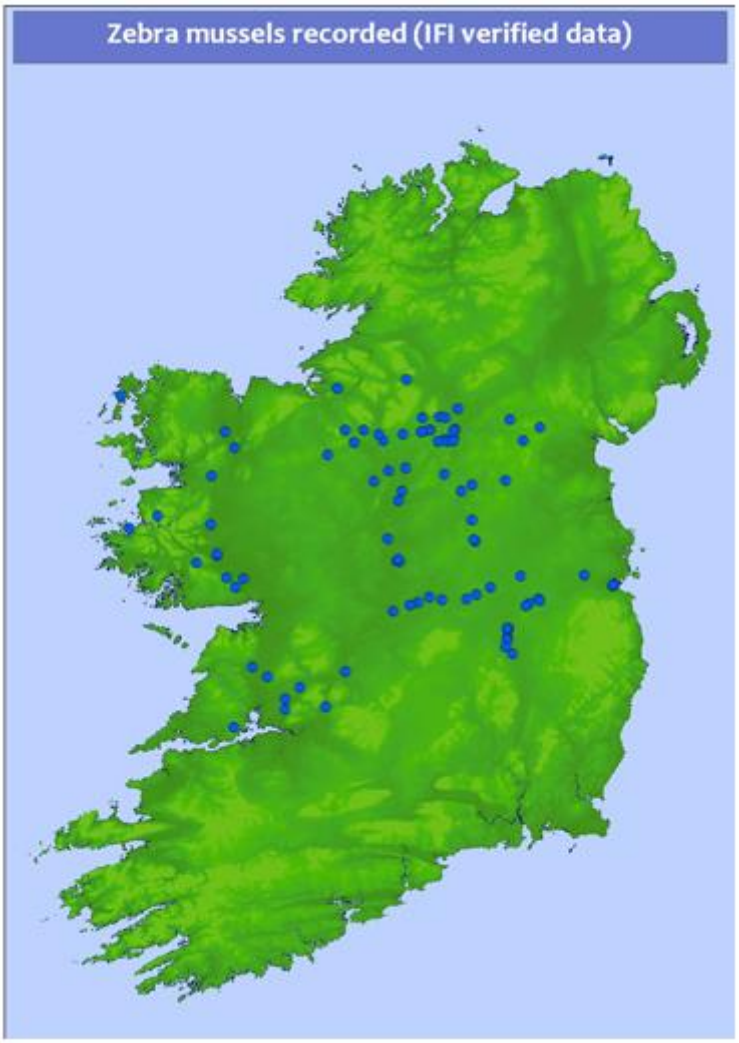
6.7.1.5 Invasive Species

Invasive species are plants or animals that have been introduced, usually by people, outside their natural range. These species can sometimes become 'invasive' when they spread rapidly and outcompete the native flora and fauna, pushing out native species or leading to environmental degradation.

There are many non-native invasive species recorded along OPW Arterial Drainage Channels. Species of concern are Giant Rhubarb (*Gunnera tinctoria*), Japanese Knotweed (*Fallopia japonica*), Giant Hogweed (*Heracleum mantegazzianum*), Himalayan Balsam (*Impatiens glandulfera*), Rhododendron (*Rhododendron ponticum*), Nuttall's pondweed (*Elodea nuttallii*) and Curly Waterweed (*Lagarosiphon major*). Highly invasive Zebra mussels (*Dreissena polymorpha*) are also a significant threat, especially in lakes, although rivers can be affected as well. Zebra mussels are widespread in Ireland (Figure 6-9). Asian Clam (*Corbicula fluminea*) has been recorded in the River Barrow, Nore, Shannon and recently found in Carrick-on-Shannon and Lough Derg. The Asian Clam, like the Zebra Mussel, has the ability of becoming highly invasive in a short period of time and at high densities it can alter the food web and compete with native mussel species (IFI, 2011).

Extreme flooding events result in further dispersal of invasive species, upstream and downstream, as well as onto land through the waterway. Many of these invasive species thrive in highly disturbed environments, where soils are routinely disturbed and transported. Machinery or equipment can also be a pathway for invasive species to spread. During the Arterial Drainage Maintenance Activities, work within stands of non-native invasive species should be avoided and the project management staff must ensure drainage activities do not contribute to the spread of invasive species.

Figure 6-9. Zebra Mussel Distribution in Ireland (IFI, 2016).



6.7.2 Threats to Flora and Fauna

- Potential effects on protected sites such as Natura 2000 sites (SAC and SPAs) and NHAs and pNHAs along with their protected flora and fauna.
- Freshwater Pearl Mussel, Atlantic Salmon, lamprey species, and White-clawed Crayfish will be particularly sensitive to pollution These species are likely to be especially vulnerable to climate change.
- Freshwater Pearl Mussel face threats from the eutrophication of rivers, intensification of agriculture, land drainage, afforestation, and degradation of riverbed habitat.
- The white-clawed crayfish is under increasing threat from floods, pollution (industrial, domestic, agricultural), habitat modification (dam, draining, dredging), overfishing, and competition with non-indigenous crayfish (Reynolds 1998). Potential threats to mammal species (otter, badger and pine marten) are habitat loss, disturbance and pollution.
- Changes to the flooding regime may have impacts on habitats and species which require particular inundation periods or in the case of groundwater dependent ecosystem, (e.g. fens) particular water supply mechanisms and water chemistry.
- Potential risk of altering fish spawning and nursery areas. Ensure clear passage for migratory fish species.
- Invasive species will continue to pose a threat to native species and can spread through waterways or contamination of equipment.
- Changes in land use, urbanisation, afforestation, or changing agricultural practices, will continue to be a threat to biodiversity, both within designated sites and outside.

- Climate change will impact flora and fauna differently and the effects could be seen on an ecosystem scale, a habitat scale, or at an individual scale.

Summary of potential impacts to ecology and Natura 2000 sites:

As noted in the Screening for AA (Volume III-Arterial Drainage Maintenance Activities 2016-2021 SEA Natura Impact Statement) the following impacts during construction and operation are considered possible from arterial drainage maintenance activity as displayed in the Table 6-18, below.

Table 6-18. Potential Impacts on Ecology and Natural 2000 Sites

Potential Threat on	Potential Impact
Morphology:	-Channel profile change -Channel straightening -Riffle-glide-pool sequence -Substrate -Riparian Zone
Channel Processes:	-Flow characteristics -Sediment transport -Impacts on water quantity and quality
Ecology and Natura 2000 sites	-Reduction in habitat diversity & stability -Removal of riffle-glide-pool sequence -Habitat deterioration -Habitat loss -Species loss and reduction in species populations -Habitat and species fragmentation -Increased turbidity, suspended solids & sedimentation -Accidental spills and pollution causing damage or loss to habitats and species -Alterations in flow regime -Impairment of riparian zone -Lowering of water levels and alterations in water quantity

6.7.3 Opportunities for flora and fauna

- Riparian areas such as alluvial forests and wetlands, should be sustainably managed, as they provide habitats, support species, and improve biodiversity.
- Protect and where possible improve important fisheries habitat within Arterial Drainage Scheme catchments, Flood Relief Scheme channels and designated channels.
- Prevent the potential introduction or spread of invasive species (e.g. Japanese Knotweed, Giant Hogweed and Giant Rhubarb).

- Improve methods and processes for managing invasive species and risk of invasive species colonisation, growth, and spread.
- Maintain or expand habitats supporting salmonid fisheries and carry out enhancement works where possible.

6.7.4 Summary Table

The summary table below (Table 6-19 and Table 6-20) display a catchment-wide checklist of some ecological sensitive areas and species in Ireland, as well as and, highlights the relevant OPW Schemes present in each catchment. The ecological sensitive areas and species detailed below based on data-available from the OPW monitoring programmes and online databases from the National Biodiversity Data Centre and the EPA.

6.7.5 Future Trend

The EU Habitats and Bird's Directives have enforced legislation in European countries that provide recognition and protection to European flora and fauna. It is likely to expect benefits to protected species and sites and the wider aquatic environment with the implementation of measures to achieve good ecological status under the WFD. The continuous development of proposals and action plans to protect biodiversity should help improve future framework and recommendations. Climate change has the potential to change the range of habitats and species in Ireland.

Changes in land-use (i.e. urbanisation, afforestation, intensive agriculture) will continue to threaten biodiversity both in designated and non-designated sites.

Table 6-19. Catchment-wide checklist of ecology in Ireland (part 1).

Catchment Name	Natural Heritage Area (NHA)	Natura 2000 SAC/SPA	Shellfish Areas	Salmonid Protected Waters	Invasive Species (Japanese Knotweed, Giant Hogweed, Giant Rhubarb)	OPW Scheme
Ballyteigue-Bannow	Y	Y	Y	N	Y	Ballyteigue,/Kilmore
Bandon-Ilen	Y	Y	Y	Y	Y	Bandon River (Dunmanway)
Barrow	Y	Y	N	N	Y	
Blacksod-Broadhaven	Y	Y	Y	N	Y	
Blackwater (Munster)	Y	Y	N	Y	Y	
Boyne	Y	Y	N	Y	Y	Boyne
Colligan-Mahon	Y	Y	Y	N	Y	Brickey
Corrib	Y	Y	Y	Y	Y	Corrib
Donagh- Moville	Y	Y	Y	N	Y	
Donegal Bay North	Y	Y	Y	N	Y	
Dunmanus-Bantry-Kenmare	Y	Y	Y	N	Y	Ouvane
Erne	Y	Y	N	N	Y	Abbey, Duff and Kilcoo
Erriff-Clew Bay	Y	Y	Y	N	Y	
Foyle	Y	Y	N	Y	Y	Donegal
Galway Bay North	Y	Y	Y	N	Y	
Galway Bay South East	Y	Y	Y	N	Y	Gort and Lackan
Gweebarra-Sheephaven	Y	Y	Y	N	Y	
Laune-Maine-Dingle Bay	Y	Y	Y	Y	Y	Maine
Lee, Cork Harbour and Youghal Bay	Y	Y	Y	Y	Y	
Liffey and Dublin Bay	Y	Y	N	N	Y	Ryewater and Hazelhatch (Shinkeen)
Lough Neagh + Lower Bann	Y	N	N	N	Y	Monaghan Blackwater
Lough Swilly	Y	Y	Y	Y	Y	Donegal
Lower Shannon (A)	Y	Y	N	N	Y	Brosna

Catchment Name	Natural Heritage Area (NHA)	Natura 2000 SAC/SPA	Shellfish Areas	Salmonid Protected Waters	Invasive Species (Japanese Knotweed, Giant Hogweed, Giant Rhubarb)	OPW Scheme
Lower Shannon (B)	Y	Y	N	N	Y	
Lower Shannon (C)	Y	Y	N	N	Y	Clareen, Nenagh, Woodford, Killmor and Carrigahorig
Lower Shannon (D)	Y	Y	N	N	Y	Groody, Mulkear Ballymackeogh, Mulkear Cappamore
Mal Bay	Y	Y	N	N	Y	Creegh and Cloghauninchy
Moy+ Killala Bay	Y	Y	Y	Y	Y	Moy
Nanny-Delvin	Y	Y	Y	N	Y	Duleek (Nanny), Matt, Broadmedow and Ward
Newry, Fane, Glyde and Dee	Y	Y	Y	N	Y	Glyde and Dee
Nore	Y	Y	N	Y	Y	Kilekenny
Ovoca-Vartry	Y	Y	N	Y	Y	
Owenavorragh	Y	Y	N	Y	Y	Owenavorragh
Shannon Estuary North	Y	Y	N	Y	Y	Shannon Embankment North, Sixmilebridge (Owenagarney),
Shannon Estuary South	Y	Y	Y	N	Y	Deel, Maigue, Shannon Embankment South , Maigue outfall
Slaney + Wexford Harbour	Y	Y	Y	Y	Y	
Sligo Bay + Drowse	Y	Y	Y	N	Y	Bonet
Suir	Y	Y	Y	Y	Y	Carrick-on-Suir
Tralee Bay-Feale	Y	Y	Y	Y	Y	Feale
Upper Shannon (A)	Y	Y	N	N	Y	
Upper Shannon (B)	Y	Y	N	N	Y	Boyle
Upper Shannon (C)	Y	Y	N	N	Y	

Catchment Name	Natural Heritage Area (NHA)	Natura 2000 SAC/SPA	Shellfish Areas	Salmonid Protected Waters	Invasive Species (Japanese Knotweed, Giant Hogweed, Giant Rhubarb)	OPW Scheme
Upper Shannon (D)	Y	Y	N	N	Y	
Upper Shannon (E)	Y	Y	N	N	Y	Ballyglass (Knockcrohery)
Upper Shannon (F)	Y	Y	N	N	Y	Inny
Upper Shannon (G)	Y	Y	N	N	Y	

Table 6-20. Catchment-wide checklist of ecology in Ireland (part 2).

Catchment Name	Freshwater Pearl Mussel	King Fisher	Otter	Lamprey	Crayfish	Badger	Bats	Natterjack Toad	Common Newt	Pine Marten	OPW Scheme
Ballyteigue-Bannow	N	Y	Y	N	Y	Y	Y	N	Y	Y	Ballyteigue,/Kilmore
Bandon-Ilen	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Bandon River (Dunmanway)
Barrow	Y	Y	Y	N	Y	Y	Y	N	Y	N	
Blacksod-Broadhaven	N	Y	Y	N	N	Y	Y	N	Y	Y	
Blackwater (Munster)	Y	Y	Y	N	Y	Y	Y	N	Y	Y	
Boyne	N	Y	Y	N	Y	Y	Y	N	Y	Y	Boyne
Colligan-Mahon	Y	Y	Y	N	N	Y	Y	N	Y	Y	Brickey
Corrib	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Corrib
Donagh- Moville	Y	Y	Y	N	N	Y	Y	N	Y	Y	
Donegal Bay North	Y	Y	Y	N	N	Y	Y	N	Y	Y	
Dunmanus-Bantry-Kenmare	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Ouvane
Erne	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Abbey, Duff and Kilcoo
Erriff-Clew Bay	Y	Y	Y	N	Y	Y	Y	N	Y	Y	
Foyle	Y	Y	Y	N	N	Y	Y	N	Y	Y	Donegal

Catchment Name	Freshwater Pearl Mussel	King Fisher	Otter	Lamprey	Crayfish	Badger	Bats	Natterjack Toad	Common Newt	Pine Marten	OPW Scheme
Galway Bay North	Y	Y	Y	N	N	Y	Y	N	N	Y	
Galway Bay South East	N	Y	Y	N	Y	Y	Y	N	Y	Y	Gort and Lackan
Gweebarra-Sheephaven	Y	Y	Y	N	N	Y	Y	N	Y	Y	
Laune-Maine-Dingle Bay	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Maine
Lee, Cork Harbour and Youghal Bay	Y	Y	Y	Y	N	Y	Y	N	Y	Y	
Liffey and Dublin Bay	N	Y	Y	N	Y	Y	Y	N	Y	Y	Ryewater and Hazelhatch (Shinkeen)
Lough Neagh + Lower Bann	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Monaghan Blackwater
Lough Swilly	Y	Y	Y	N	N	Y	Y	N	Y	Y	Donegal
Lower Shannon (A)	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Brosna
Lower Shannon (B)	N	Y	Y	N	Y	Y	Y	N	Y	Y	
Lower Shannon (C)	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Clareen, Nenagh, Woodford, Killmor and Carrigahorig
Lower Shannon (D)	N	Y	Y	N	Y	Y	Y	N	Y	Y	Groody, Mulkear Ballymackeogh, Mulkear Cappamore
Mal Bay	N	Y	Y	N	N	Y	Y	N	Y	Y	Creegh and Cloghauninchy
Moy+ Killala Bay	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Moy
Nanny-Delvin	N	Y	Y	N	N	Y	Y	N	Y	Y	Duleek (Nanny), Matt, Broadmedow and Ward
Newry, Fane, Glyde and Dee	N	Y	Y	N	N	Y	Y	N	Y	Y	Glyde and Dee
Nore	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Kilekenny
Ovoca-Vartry	Y	Y	Y	N	N	Y	Y	N	Y	Y	

Catchment Name	Freshwater Pearl Mussel	King Fisher	Otter	Lamprey	Crayfish	Badger	Bats	Natterjack Toad	Common Newt	Pine Marten	OPW Scheme
Owenavorragh	Y	Y	Y	N	N	Y	Y	N	Y	Y	Owenavorragh
Shannon Estuary North	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Shannon Embankment North, Sixmilebridge (Owenagarney),
Shannon Estuary South	N	Y	Y	N	Y	Y	Y	N	Y	Y	Deel, Maigue, Shannon Embankment South, Maigue outfall
Slaney + Wexford Harbour	Y	Y	Y	N	Y	Y	Y	N	Y	Y	
Sligo Bay + Drowse	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Bonet
Suir	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Carrick-on-Suir
Tralee Bay-Feale	Y	Y	Y	N	N	Y	Y	Y	Y	N	Feale
Upper Shannon (A)	N	Y	Y	N	Y	Y	Y	N	Y	Y	
Upper Shannon (B)	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Boyle
Upper Shannon (C)	N	Y	Y	N	Y	Y	Y	N	Y	Y	
Upper Shannon (D)	N	Y	Y	N	Y	Y	Y	N	Y	Y	
Upper Shannon (E)	N	Y	Y	N	Y	Y	Y	N	Y	Y	Ballyglass (Knockcrohery)
Upper Shannon (F)	N	Y	Y	N	Y	Y	Y	N	Y	Y	Inny
Upper Shannon (G)	N	Y	Y	N	Y	Y	Y	N	Y	Y	

6.8 Cultural Heritage

6.8.1 Introduction

Ireland's earliest archaeological sites date back to the end of the last Ice Age, 10,000 years ago. They consist of evidence of temporary settlements of fishermen, hunters and gatherers that survived as scatters of stone implements and shell mounds or middens (National Monument Service, 2016). However, structures and remains from any time period can be considered of archaeological interest.

Monuments of archaeological importance are protected under the National Monuments Acts 1930-2004. The National Monuments Service of the Department of Arts, Heritage, Regional, Rural, and Gaeltacht Affairs (DAHRRGA) maintains a record of all known monuments and this forms the Records of Monuments and Places (RMP). There are approximately 120,000 RMPs and these are published county-by-county and include registered monuments and National Monuments. These include burial grounds, standing stones, medieval churches, tower houses, ring forts, bridges, fishing weirs, and mills among many other sites. While the bulk of the sites in the registers date to the period before circa 1750 AD, the National Monuments Services (NMS) increasingly recognizes sites that are younger and will include all sites that are 100 years old. The NMS also maintains the Historic Shipwreck Inventory, which addresses specifically the incidents and locations of recorded and known shipwreck sites. There are more than 18,000 shipwreck event entries for the inland waterways alone.

The NMS, guided by the National Monuments Act of 1930, treats any artificial or partly artificial building, structure, or erection as a monument, and treats all monuments equally in terms of the importance of their archaeological potential. No one site type or category is deemed to be more or less important than another so that, for example, a fulacht fiadh or burned mound ancient cooking site is considered to share the same level of importance and be afforded the same level of protection as a standing medieval castle complex. It is therefore not the case that different archaeological sites can be considered to have greater or lesser potential or importance. All sites are equal in this regard. As. Figure 6-10, Figure 6-11, and Figure 6-12 (see three figures accompanying) demonstrate, the distribution and density of known archaeological monuments across Ireland is widespread and significant, with many sites located close to and on river bodies.

Any work proposed near an RMP or Historic Shipwreck site requires written notice to the Department and licensed consent from the Department before such works can take place. Any work proposed near a National Monument or within a World Heritage Site (which can be a landscape area and not just a standing structure, for example Brú na Bóinne on the River Boyne) requires written notice to the Minister and licensed consent from the Minister. In addition to monuments, structures and wreck-sites, river channels and freshwater bodies are known to retain high archaeological potential for the recovery of artefacts and objects that have been deposited either with intention (e.g. votive offerings) or were lost. The National Museum of Ireland maintains the register of archaeological objects reported, which should be consulted in advance of proposed works. The Planning and Development Act 2000 (as amended) requires that development plans contain objectives for the protection of the archaeological heritage and architectural conservation areas and conditions relating to archaeology to be attached to individual planning permissions (National Monument Service, 2016). This includes works proposed above and below the waterline.

It is also necessary to consider the potential to discover new sites and features on any given river system. New discoveries result from activities that occur within a river system, whether by natural means (erosion and deposition) or human-induced means (for examples drainage schemes and development activities). New discoveries can be identified by careful examination of existing cartographic and related sources. Figure 6-13 Shannon Estuary North and South WFD Catchment, for example, show the results arising from a desk-based assessment of the Shannon Estuary, focussed on the. New discoveries are also made because of field inspection, and this is why it is of great importance to carry out field inspection above and below the waterline as part of the pre-works programmes for arterial drainage schemes. New discoveries include more humble site types as well as the more obvious structures associated with former settlement and industrial/riverine activities, and can include features such as historic flood embankments, river walls, jetties, riverside steps and moorings, none of which will typically be

part of the existing registers of monuments, but all of which are considered to retain archaeological potential.

The National Inventory of Architectural Heritage (NIAH) is a state initiative under the administration of the DAHRRGA and established on a statutory basis under the provision of the Architectural Heritage (National Heritage) and Historic Monuments (Miscellaneous Provisions) Act 1999 (Buildings of Ireland, 2016). The NIAH aims to identify, record, and evaluate post-1700 architectural heritage in Ireland, as a measure to protect built heritage.

Early human inhabitants on the island settled near bodies of water (coast, lakes, and rivers) because watercourses provided sources of food, communication, and transportation, while also historically demarcating territories. Ports, bridges, ferries, and settlement on Irish Rivers evolved over time, tributaries of main watercourses were altered to provide power, drinking water, and for draining land. For that reason, there are sites and evidence of human life adjacent to river bodies or arterial drainage schemes. Peatlands and estuaries are known for their ability to preserve artefacts, therefore, works carried out in these environments must follow special precautions, as the likelihood of encountering objects of cultural or historical importance is higher than in other landscapes. During the construction and excavation of the original arterial drainage scheme, features of archaeological importance were recovered. For that reason, during the Arterial Drainage Maintenance Activities (2016-2021), it is necessary to follow standard archaeological procedure when carrying out works, in accordance with the OPW SOPs outlined above in Section 3.4. The OPW will appoint a project archaeologist who is qualified and experienced in riverine archaeology, who will manage and/or carry out the assessment. This requires a staged approach of initial archaeological risk assessment based on desktop review and on-site inspection (walkover survey and/or waded and underwater inspection), making appropriate impact assessment, and following a set of mitigation measures to resolve the archaeological risk within the context of the project works where impact avoidance is not possible.

Figure 6-10. Lough Swilly WFD Catchment SMR

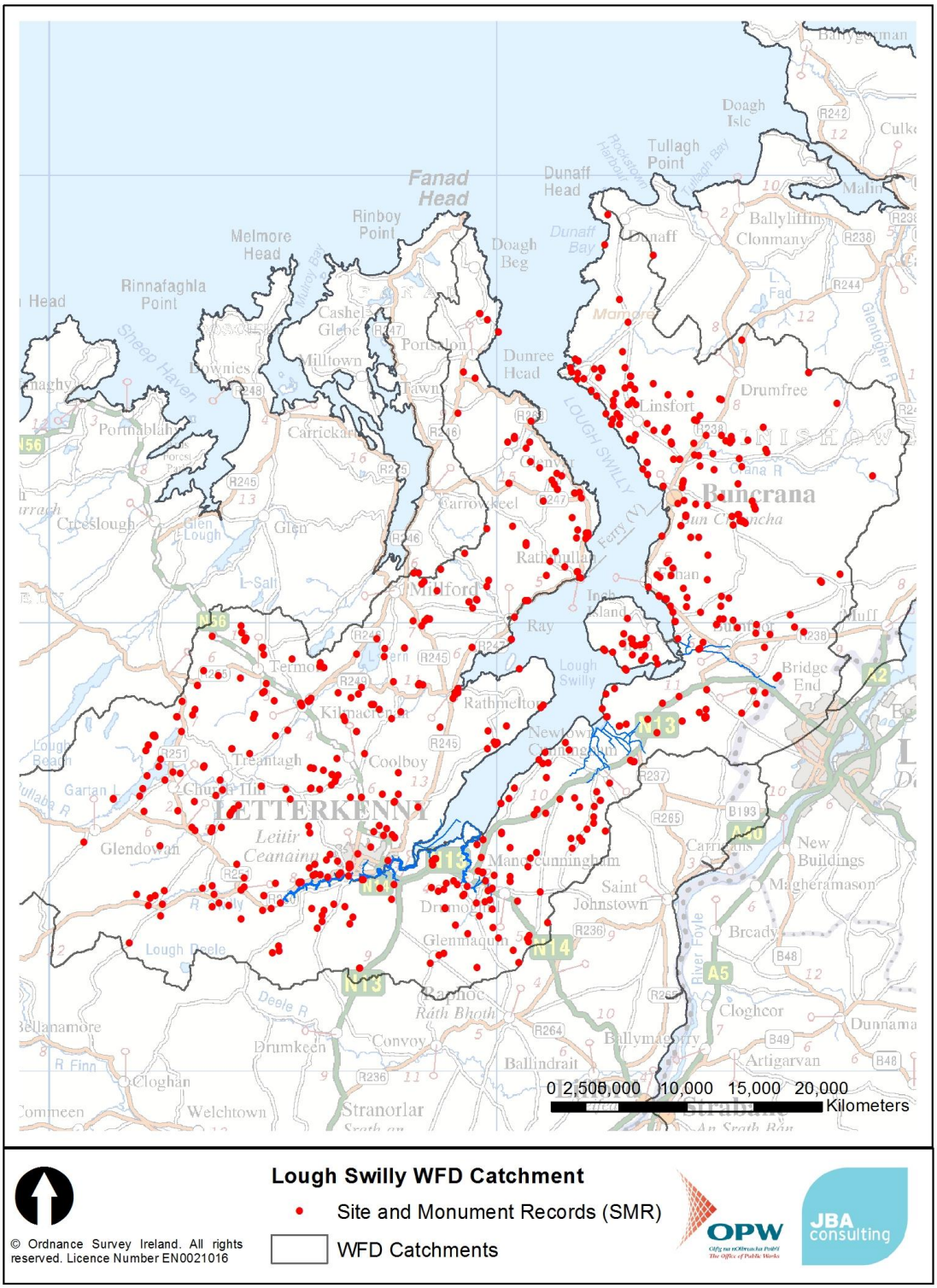


Figure 6-11. Moy and Killala Bay WFD Catchment SMR

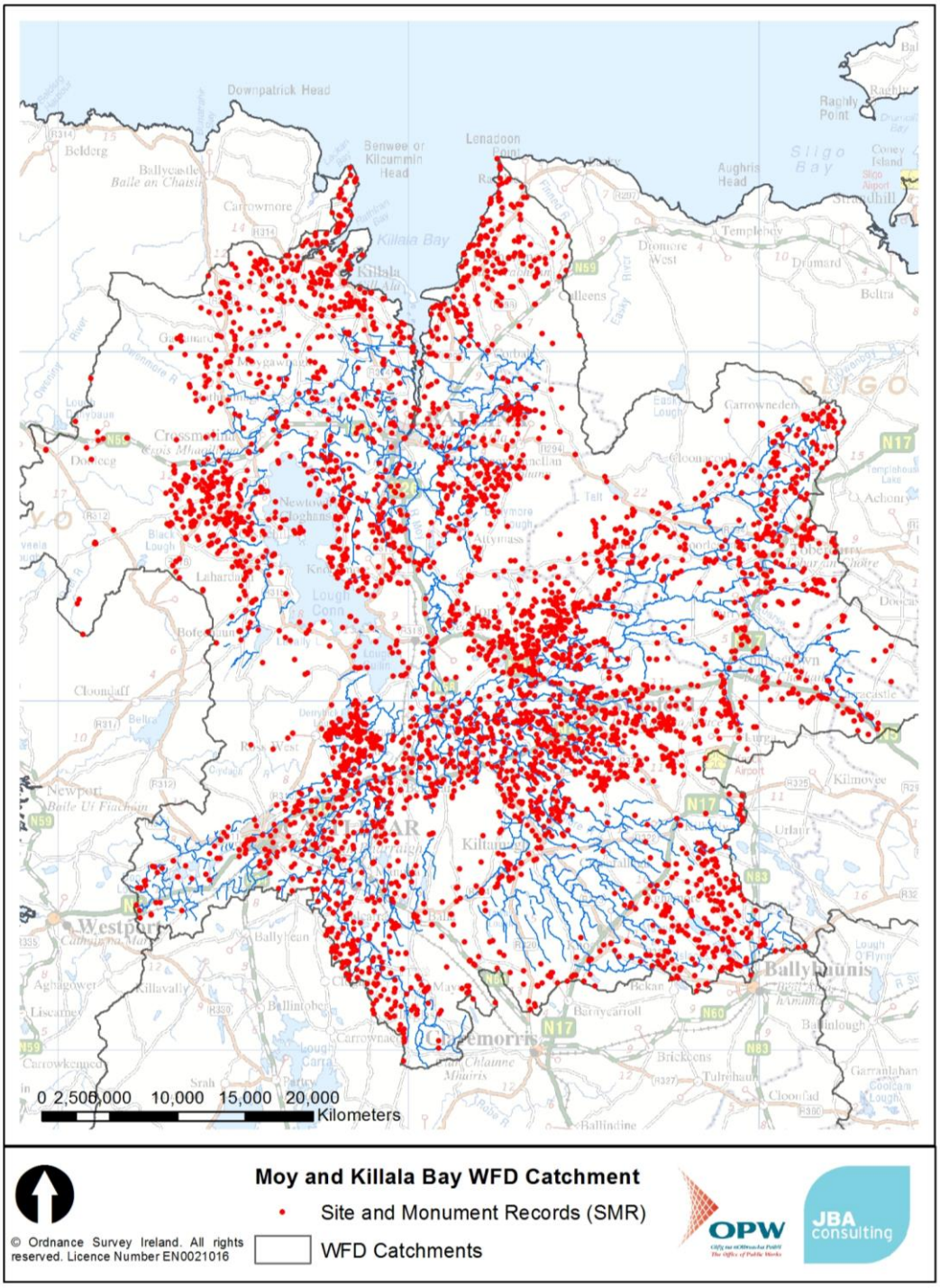


Figure 6-12. Upper Shannon WFD Catchment SMR

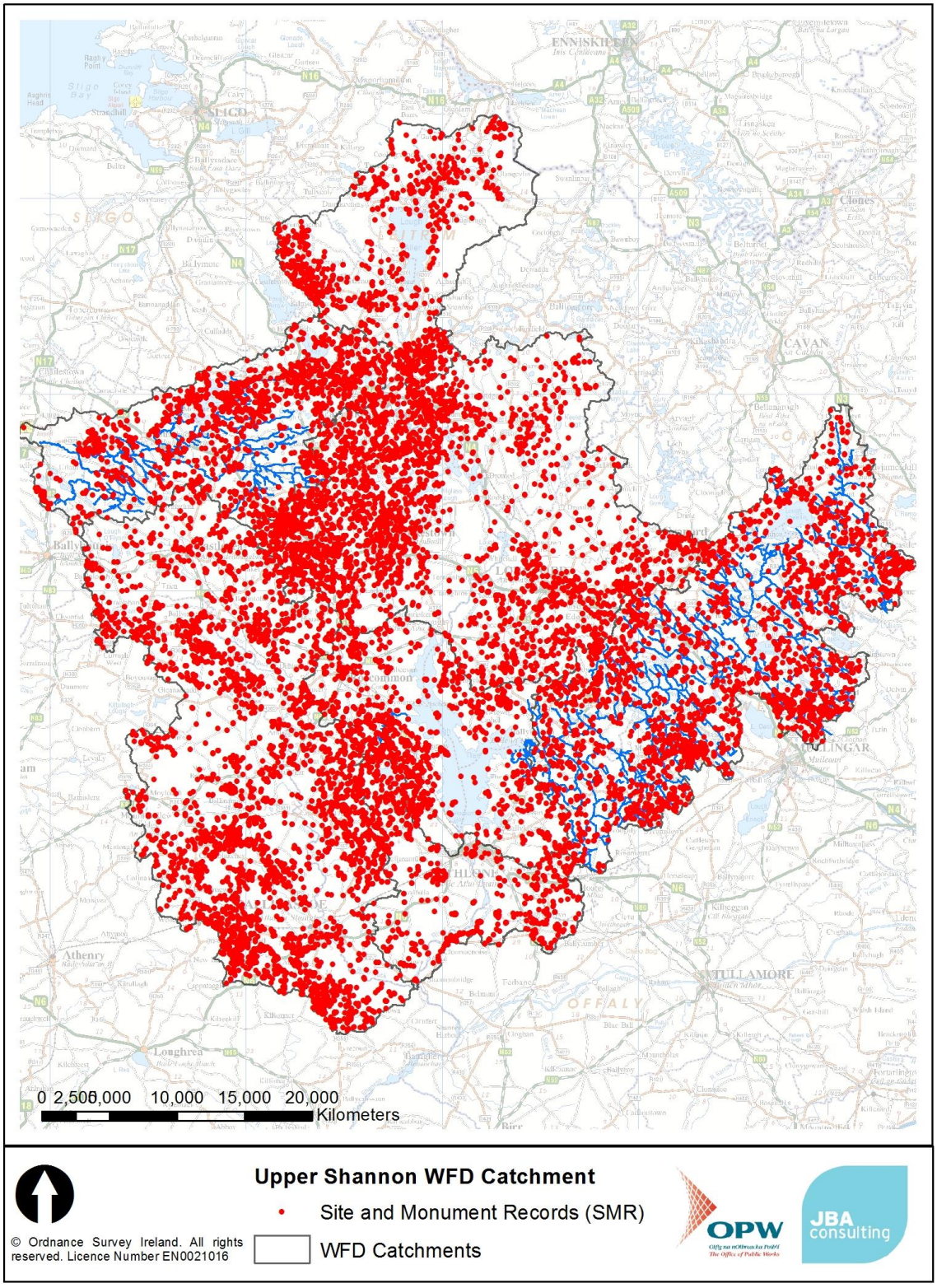
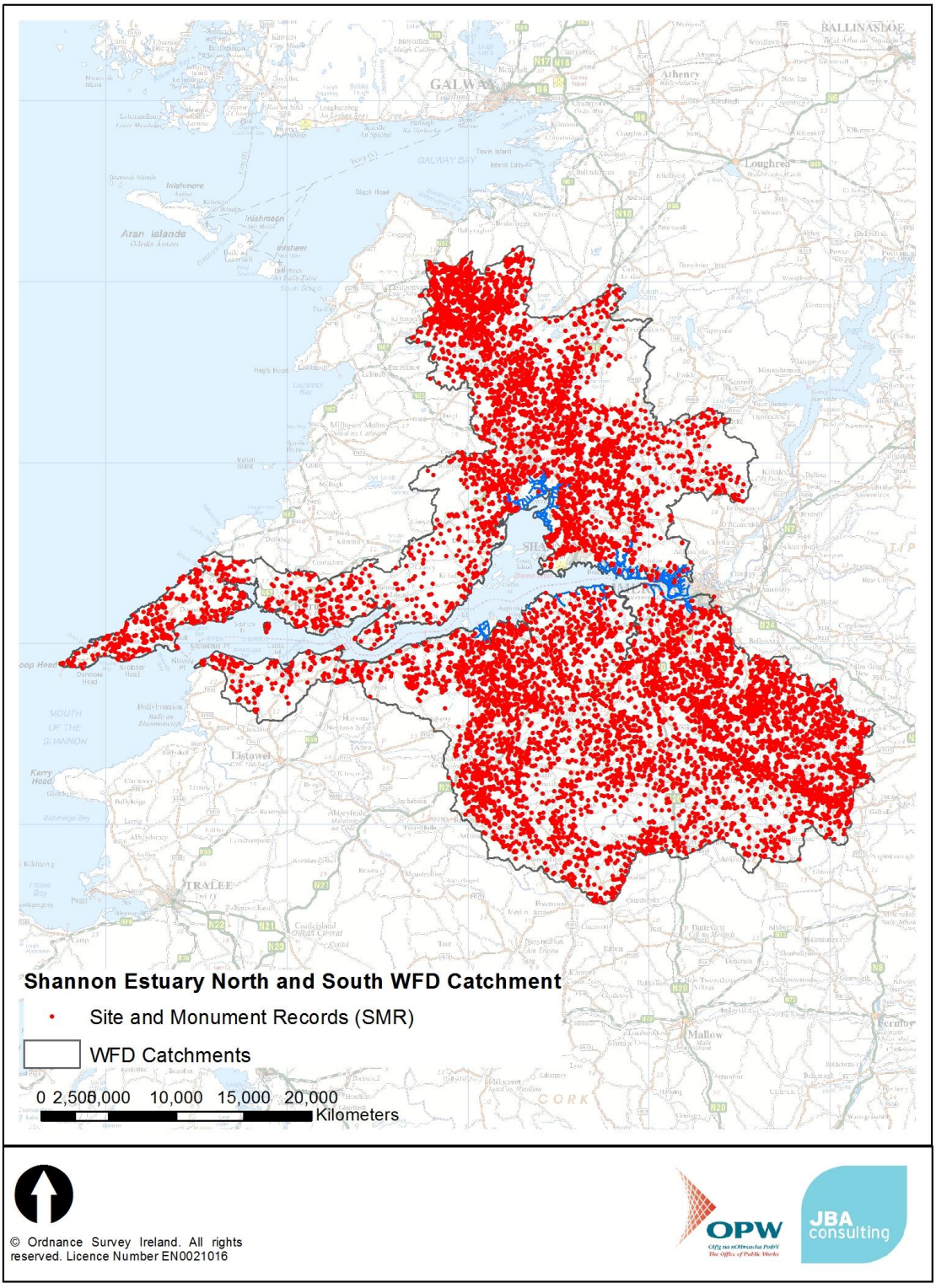


Figure 6-13. Shannon Estuary North and South WFD Catchment



6.8.2 Future Trends

Cultural heritage and archaeological features face a growing threat posed by development pressures and urbanisation. The identification and protection of existing designated sites, structures, buildings and unknown, buried or submerged archaeological interests will be required, for any new designations. There are important areas, structures, or buildings that could be at risk of flooding, and there are standard archaeological procedures and protocols to resolve these assets within work programmes, as identified and prepared in other sectors of archaeological work (for which, see: https://www.archaeology.ie/codes-of-practice), and as described in Section 3.4 above.

6.8.3 Threats of Cultural Heritage

- National Arterial Drainage Maintenance Activities (2016-2021) will be constrained by the need to protect the setting of areas of existing archaeological and architectural value (i.e. Monuments, RMP, and NIAH). For that reason, assessments should be implemented and carried out by archaeologists experienced in riverine and underwater archaeology, to record and map the nature and extent of the cultural heritage assets along river courses in advance of drainage maintenance activities and as part of the pre-works surveys.
- Fording points and other natural shallows retain archaeological potential and need to be considered as sites of archaeological interest during arterial drainage maintenance operations, Flood Relief works and related operations.
- Invasive species. The impact of invasive species on lake-bed and river-bed environments has yet to be investigated from an archaeological perspective. Invasive species appear to blanket lake- and river-beds with wide-spread growth patterns that mask and bury known archaeological sites. It is not known whether this process is causing damage to archaeological sites and features. Assessment studies need to be aware of this factor and should begin to address the threat associated with the presence and spread of invasive species.
- Changes to the flooding regime may have impact on archaeological and architectural heritage sites and areas of archaeological potential. Flooding can cause acute erosion and deposition, which can impact on known structures and features as well as areas of soft sediment entrapment, where it is likely for artefacts to become deposited. Archaeological assessments need to aware of the wider river channel topography to take account of likely flooding impacts.

6.8.4 Opportunities for Cultural Heritage

- Establish baseline knowledge of the cultural heritage assets in river channels by new assessment surveys based on desktop sources and field inspection, which will inform Arterial Drainage schemes, Flood Relief Schemes, and relative river protection and management projects nationwide.
- Understand riverine impacts on cultural heritage assets by engaging with fluvial dynamic studies.
- Understand ecological impacts on cultural heritage assets by engaging with invasive species and related studies.
- Improve methods and processes for managing cultural heritage assets through integrated study and engagement with stakeholders.
- Engage with the Public and other stakeholders at community, regional and national level, to demonstrate the value of historical knowledge of river usage in contributing to current and future planning for river systems management.
- OPW to become a recognized national leader in the progressive management of the cultural heritage assets within river systems.

6.9 Climate Change

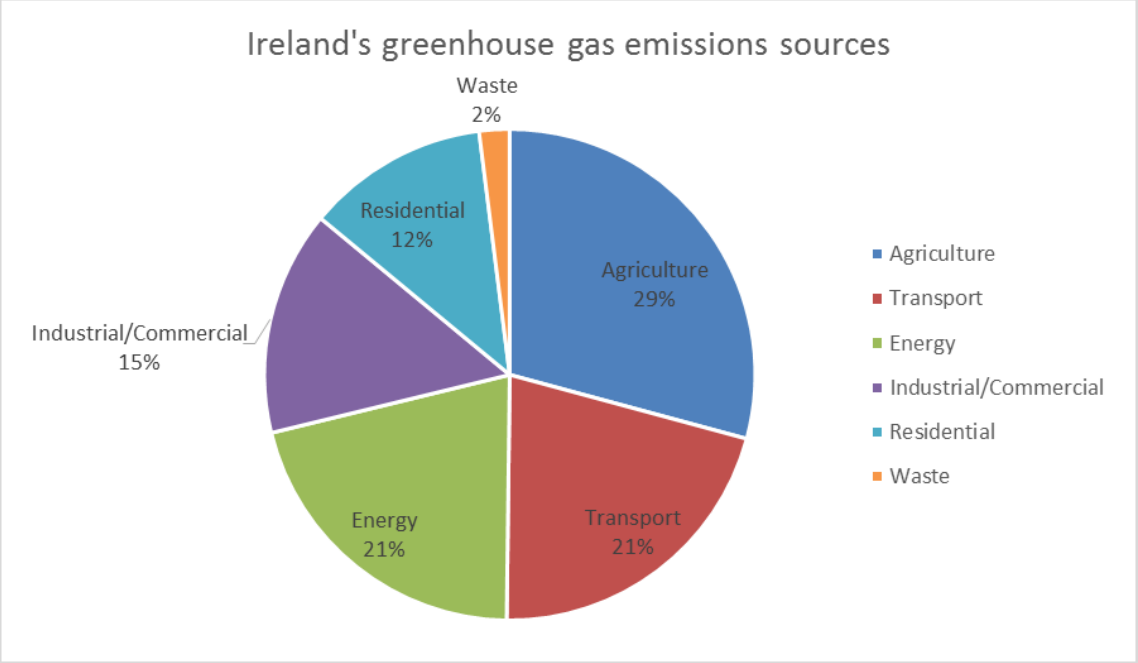
6.9.1 Introduction

Climate change is described by the scientific community as a significant change in the average weather around the world, this involves variations in temperature, rainfall, wind, lasting for an extended period of time. Natural climate change has occurred during the planets history, with events ranging from ice ages to periods of higher temperature. The problem is that anthropogenic changes are influencing climate change through emissions of greenhouse gases. Human interference increases air and ocean temperatures, which result in droughts, melting ice and snow, rising sea levels, increased rainfall, and flooding. It is also believed an increase of extreme weather events (annual hurricanes, tornadoes, and earthquakes) is related to the variation of weather around the planet.

Both human and natural processes influence climate change. Natural processes include changes in the sun's intensity, volcanic eruptions, or processes within the climate system such as ocean current circulation. Human activities that impact the composition of the atmosphere include: carbon dioxide (CO2) emissions from the burning of fossil fuels (coal, oil, peat); methane and nitrous oxide from agriculture and waste management; and emissions through land use changes (deforestation, afforestation, urbanisation, and desertification). The International Panel of Climate Change (IPCC) believe that the observed increase in global temperature is a result of anthropogenic contributions to climate change.

Ireland's greenhouse gas emissions arise from a mixture of activities. The EPA compiled greenhouse gas figures for Ireland in 2009, these are displayed in the Figure 6-14, below.

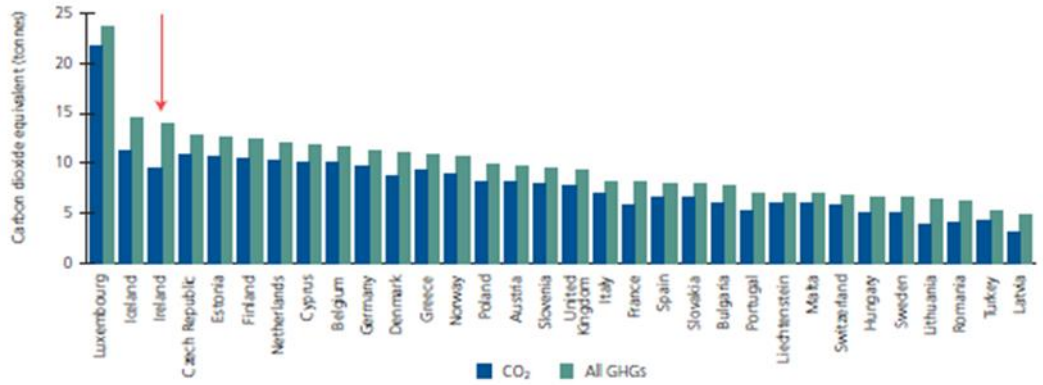
Figure 6-14. Ireland's greenhouse gas emissions by sector for 2009 (Source EPA, 2011).



The sources of greenhouse gas emissions for the industrial sector are regulated by the EPA through the EU Emission Trading Scheme (EU-ETS) and associated Greenhouse Gas Permits. The main sources of non-ETS greenhouse gas emissions are agriculture (29%), energy (21%), and transport (21%). Although there may have been some changes in the levels of greenhouse gas emission with the implementation of policy and legislation, it is likely that these will still dominate as the main source of emissions. Land use change is also a factor that contributes to greenhouse gas release, activities such as deforestation, afforestation, removal of peat for fuel and/or the drainage of peatlands, all have significant effects on the environment such as release of greenhouse gases and/or contamination of surrounding surface water or groundwater systems. For that reason, the conservation of these habitats and the control/limitation of some activities are crucial to help mitigate climate change.

Ireland has a high level of emission per capita compared to other European countries (Figure 6-15).

Figure 6-15. Total greenhouse gas emissions and CO2 emissions as Tonnes CO2 per person by Country in 2009.



There are various carbon sinks in Ireland such as peatlands, forestry, and other soils, grasslands, and habitats. Natural peatlands act as long-term carbon storage, however, when peatland is cut, carbon dioxide (CO2) and other greenhouse gases, specifically methane, are released into the atmosphere. According to Wilson *et al* (2007), there are 270-455 billion tonnes of carbon stores in boreal and sub-arctic peatlands around the world. The ability of peatlands to continue to actively remove and store carbon and act as a buffer to climate change depends on the degradation status of individual peatlands. Irish peatlands make up approximately 17% of the country's land area and store 1.2 billion tonnes of carbon, which is equivalent to 4.4 billion tonnes of carbon dioxide. Unfortunately, approximately 80% of Irish peatlands have been damaged to some extent (Reour-Wilson *et al*, 2011). For that reason, the restoration of peatland around the country is crucial for meditating climate change and meeting annual target. Similarly, Irish forests also have the ability to store and sequester carbon and should play an important role in climate mitigation.

Ireland has had various improvements in its ambient air quality since the introduction of a number of legislative measures around acid rain, and photochemical smog, beginning in the early 1990s. There are two EU Legislations which require the comprehensive monitoring of air quality, the Clean Air for Europe (CAFÉ) Directive and the Fourth Daughter Directive (2004/107/EC) which set limits and target values for ambient concentrations of air pollutants harmful to human health and the environment (EPA, 2015). More recently, the Climate Action and Low Carbon Development Act (2015) is Ireland's first ever climate legislation providing a statutory basis for the national objectives of transition to a low carbon, climate resilient and environmentally sustainable economy by the year 2050.The act provides a statutory foundation to the institutional arrangements necessary to enable the state to pursue and achieve the national objective. The act requires the preparation of successive 5-yearly National Mitigation Plan and a successive 5-yearly National Adaptation Framework.

6.9.2 Threats from Climate Change

- Increased risk of coastal, fluvial, and pluvial flooding.
- Increased rainfall and sea level influencing the ability of arterial drainage schemes and embankments to function as designed.
- The release of greenhouse gases as a result of altering or cutting bog and peatlands.
- Greenhouse gas emissions from machinery, vehicles and materials used to undertake maintenance activity.
- For small coastal schemes, sea level rise alone could result in the existing scheme being unable to provide its intended function. It is important to consider how climate change predictions could prompt a change in land-use to adjust accordingly. The potential challenges that could be faced are the following:
    - Increased flood risk from embankments and schemes through asset failure.
    - Decreased drainage capacity of benefitting lands due to increased rainfall.
    - Importance of adaptive capacity in flood relief and drainage schemes to continue to provide their intended function and also other as yet unknown functions, such as water storage for irrigation or human water supply.

6.9.3 Opportunities for Climate Change

- With a sustainable management strategy that allows for adaptive capacity to be maximised, flood protection and land drainage function could be continued into the future. There is also the potential for schemes to provide enhanced flood protection where there is potential significant projected flood risk
- Protection, conservation and enhancement of existing carbon stores (e.g. peatlands and forest) can offer some contribution to the net carbon budget of the state. This could be achieved through careful planning of maintenance activity to maximise ecosystem conditions.
- Reduction in greenhouse gas emissions from continual evolution of machinery and vehicle fleet used in drainage maintenance activity. Also an opportunity to consider of the carbon footprint of materials used.

6.9.4 Future Trends

Since climate change is the most significant challenge facing future generations significant declines in greenhouse gas emissions are necessary to avoid irreversible impacts. The UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol are international conventions addressing causes, consequences, and potential mitigation measures for climate change. In the European Union, the Climate and Energy Package and the Adaptation Strategy provide guidelines for Irish action. The National Climate Change Strategy focuses on developing a strategy for Ireland to meet the GHG emissions limits set under the Kyoto Protocol. Ireland utilises several policy instruments, both domestic and EU, to help mitigate GHG emissions such as EU Emissions Trading Scheme and CAP Reform, and national carbon tax and policies to promote low emissions. There are other actions and plans in place in various sectors in Ireland including the Delivering a Sustainable Energy Future for Ireland, the National Bioenergy Action Plan, the National Energy Efficiency Action Plan, Smart Travel-A Sustainable Transport Future, and the Government's White Paper on Low Carbon Future for Ireland (2015). The Food Harvest 2020 plan should be carried out in a sensible way to ensure that any potential rise in greenhouse gasses from the agricultural sector is recognised and mitigated. According to the EPA's State of the Environment Report (2015), Ireland will not meet it's 2020 Kyoto and European commitment. The EPA's projections for GHG emissions from the non-ETS sector in 2020 estimated that the levels of GHG will be 14% higher than in 2014. Strategies and plans to protect important habitats in Ireland have been introduced such as the National Peatland Strategy (2015) produced by NPWS and the DAHG, in hopes of implemented better management guidelines for Ireland's peatlands and prevent further degradation, similarly the Draft National Forestry Programme 2014-2020.

The Climate Action and Low Carbon Development Act (2016) and the National Climate Change Adaptation Framework (2013) and the OPW Climate Change Sectoral Adaptation Plan for Flood Defence, all address the potential predictions of climate change and potential strategies to mitigate and adapt to climate change impacts. The Climate Action and Low Carbon Development Act, 2015 was published in 2016. In summary, the act requires the government to prepare a National Climate Change Adaptation Framework. On a local level there is a requirement for Local Authorities and Government Bodies to prepare Local Adaptation Strategies and Mitigation Plans. These Plans need to be submitted by December 2017. A recognition by a Local Authority of climate change and the increased risk of flooding will ensure that land will be adequately zoned in areas not at risk. This will have social and economic benefits.

Climate predictions

The Met Eireann publication of 'Ireland's Climate: The Road Ahead' (2013) based on downscaled global climate simulation models for Ireland predicts potential changes in climate. It is anticipated that mean temperatures will increase by 1.5 degrees by 2050. These warm temperatures will become more evident in winter and summer, which will experience a 3 degree and 2-degree rise, respectively. Winters are expected to be wetter with increases of up to 14% in precipitation (under the high emissions scenario) and the frequency of heavy rainfall events will rise to up to 20%. Summers are also expected to be drier (approximately 20% in reduction of precipitation under the high emissions scenario). These climate change impacts vary by region with the South East likely to experience the greatest increase in summer temperatures and the West experiencing the increase in winter rainfall. The changes in precipitation are likely to alter the river catchment hydrology. Expected mean height of waves is estimated to reduce while winter and spring storms wave heights are likely to rise. Mean sea level is also predicted to increase.

Although the specific impacts in Ireland are difficult to foresee, certain changes can be predicted such as heavier winter storms which could result in flash flooding, increase diffuse pollution loads from soil run-off and raising demands for flood controls. Summer drought may be more likely and may reduce drinking water supplies. Temperature rises could give invasive species a competitive advantage, thus impacting native flora and fauna, Sea level rise may also impact and influence water management.

In order to ensure sustainable water use, changes in rainfall patterns should be accounted for and the further impacts on water availability. A focus on water conservation programs should be prioritised to increase storage capacity. Buffer zones around water bodies are an effective preventative measure ensuring that the habitat can mitigate changing condition, while improving soil and sub-soil conditions (water retention).

Similarly, climate considerations should be given to design standards for infrastructure (SUDS etc.) which may have to endure more frequent storms.

6.10 Inter-relationship

In accordance with the SEA Directive, the inter-relationship between the SEA environmental topics must be considered.

Key interrelationships arise between water, biodiversity, flora, and fauna, geology and soils, land use, and human beings. It is important to recognise that the impact on one receptor will directly or indirectly influence the rest. A sustainable approach to management is necessary for a comprehensive methodology for the Arterial Drainage Maintenance Activities (2016-2021).

The relationship between biodiversity, flora, and fauna and water resources in Ireland is very important because the aquatic environment (eg. Freshwater Pearl Mussel, Atlantic Salmon) directly depends on the quality and quantity of water resources. Terrestrial/wetland habitats rely indirectly on water to sustain environments such as turlough, peatlands, wetlands, and fens, which supports high levels of biodiversity (flora and fauna). Good water quality also supports fisheries populations, which in turn delivers a valuable amenity resource, along with direct recreational use of the water environment. In addition, water quality is crucial for human health as it provides drinking water to nearby populations.

Humans, land-use, and infrastructure are interconnected since they are influenced by population dynamics, growth, and movement (urbanisation etc). These receptors are also dependent on the Irish and European economy, as well as, the political agenda of the country at the time. These receptors cause anthropogenic changes to the natural environment, therefore, directly impacting

water, flora, fauna, and biodiversity, soil and geology, and in the long-term impacting air and climate change.

Cultural heritage sites and artefacts are crucial to understand human evolution and history, for that reason, the maintenance and protection of these are very important. Land-use changes, infrastructure change/construction, urbanisation, and flooding are all developments that could cause potential threat to these areas or items.

	Human Being	Land-Use	Flora, Fauna, Biodiversity	Water	Cultural Heritage	Material Assets	Air and Climate Change	Soil and Geology
Human Being	✓							
Land-Use	✓	✓						
Flora, Fauna, Biodiversity	✓	✓	✓					
Water	✓	✓	✓	✓				
Cultural Heritage	✓	✓	✓	✓	✓			
Infrastructure and Material Assets	✓	✓	✓	✓	✓	✓		
Air and Climate Change	✓	✓	✓	✓	✗	✓	✓	
Soil and Geology	✓	✓	✓	✓	✓	✓	✓	✓

✓=Interrelationship anticipated

✗=No Interrelationship anticipated

The purpose for the proceeding sections of this section was to provide an understanding of the current environmental status of the environment. It allows the identification of threats to the environment and protected habitats and species and will be used as a marker for the assessment stage of this Environmental Report. There are some inter-relationships between topics, for example a change in one environmental feature may have a knock-on (either direct or indirect) on another environmental feature or species. A summary of the key interactions between topics relevant to the National Arterial Drainage Maintenance Activities (2016-2021) and the environment contained therein are outlined below:

- Water. This is a vital resource in the study area from an ecological and economic point of view. It provides an outlet for tourism, potable water and supports populations of salmon and freshwater pearl mussel.
- Flora and Fauna. Any impacts on water quality can have a direct impact on flora and fauna in the area. The ecology can also be indirectly impacted by development in the area, use of water as potable supplies, and impacts due to recreational and tourism
- Hydromorphology. This can impact directly on water quality, can be affected by modification to river beds, placement of structures in a river or coastal area. It can also affect the ecology of a river bed by the removal of suitable sediment for breeding, resting or feeding
- Landscape and visuals. Affected by changes in flora species composition and abundance, type of land use and the form and extent of the built environment.
- Humans and human health. A supply of potable water, clean air, recreation to sustain quality of life.

- Economics and Tourism. This part of the country relies heavily on tourism. Fisheries, clean water and a clean environment all contribute to economics and tourism.
- Development, material assets and infrastructure. Linked to population growth and associated infrastructure and material assets to support the population.
- Archaeology and Cultural Heritage. Linked to population growth, land use, and water use

6.11 Summary of Environmental Constraints

Table 6-21. Summary of environmental constraints

SEA Topic	Threats and Opportunities
Human Beings	It is important to consider the areas where the works are being carried out and its susceptibility to flooding. Consider residences/housing locations both upstream and downstream of the works. It is necessary to ensure that the works will not increase the risk of flooding (i.e. complete removal of treeline/riparian vegetation, increases erosion and in turn rate at which runoff and sediment discharge to watercourses) by impacting the flows or removing areas of water accumulation/storage. The consideration for areas both upstream and downstream of the potential works is crucial. Arterial Drainage cannot eliminate the risk of flooding. Most of the OPW arterial drainage schemes are designed to reduce flooding of agricultural land on average to the 1 in 3 annual probability design standard. Therefore, flood risk from climate change and changes in land management practices may not be mitigated through Arterial Drainage Maintenance Activities (2016-2021). In-channel works have the potential to cause diffuse pollution or release of settle-able solids which could impact water quality, directly or indirectly, affecting recreation activities (angling) or fishing. The Wild Atlantic Way and Ireland's Ancient East are two major touring routes/destination themes which cover the majority of the areas included in the Arterial Drainage Maintenance Scheme. The high quality environment is a key selling point of these destinations, therefore any risk of degradation of environment and aesthetics posed by the Arterial Drainage Maintenance Activities (2016-2021) could be a threat to tourism and recreation based economy. Some flood risk alleviation for residences near channels as a result of drainage and maintenance. It is also important to recognise the benefit of drainage schemes and maintenance activities for agricultural and benefitting lands. Where possible the maintenance activities could enhance the landscape character of the river corridors or channels in sections with valuable landscape characteristics. Maintenance activities such as trimming of trees/branches, tree cutting, or bank protection can in some cases create or clear access routes and/or paths along the river corridor which can be used for tourism or recreational purposes (angling especially) as experienced in various areas along the Moy scheme.
Water	Water quality and biological potential of surface water have major pressures which comprise of diffuse pollution of fine sediments and other pollutants such as nutrients from the agriculture and industry. There could be potential impacts on drinking water abstraction points downstream of proposed maintenance activity sites. In some cases, arterially drained channels can act as pathways to pollutants into other watercourse or groundwater/aquifers. Hydromorphological changes such as sediment production, water/sediment/wood flux, river channel adjustment, lateral connectivity which influence processes (i.e. pools, riffles, bars) can lead to habitat degradation, impacting the WFD ecological status. Climate change impacts on water quality due to increased storm events, rainfall and flooding with the potential to change hydromorphology of river beds, cause bank erosion, and re-suspended nutrients. Changes in water quality could create pressure and impacts on the ecological and chemical status of waterbodies: river, lakes, ponds, standing waters, and other wetlands including peatlands. Arterial Drainage Maintenance Activities (2016-2021) works should not interfere in accomplishing the goals set out by the WFD, the second cycle of RBMP objectives, and any other programmes or measures that aim to protect water quality (i.e. nutrients). Arterial drainage maintenance activities prevent the deterioration of channel conditions due to unprecedented erosion and/or blockage, which could result in diffuse pollution of the channel (erosion/sediment discharge) or increase the risk flooding. Maintenance works such as silt vegetation management, bush cutting/branch trimming, aquatic vegetation cutting among other activities help mitigate potential impacts and helps improve the lateral and longitudinal hydraulic connectivity of the channel. Integration of environmentally sensitive land and catchment management, and arterial drainage maintenance could reduce the silt deposition and vegetation growth in channels, which could reduce the frequency and scale of maintenance required. Opportunities along river channels for river restoration and ecological enhancement beyond EREP criteria. The REFORM tools and guidance may present opportunities and mechanisms to implement catchment restoration whilst maintaining land drainage functions.

SEA Topic	Threats and Opportunities
	All arterial drainage maintenance activities being proposed should fully consider any WFD implications and, wherever possible, link to and support the programme of measures in the RBMP. The impacts on water quality due to both the immediate increase in sediment in the water and long-term (release of nutrients into a water body and increase occurrence of eutrophication) should be fully considered.
Morphology, geomorphology and hydromorphology	Proposed arterial drainage maintenance activities must be compatible with any WFD requirements to restore the natural morphology of waterbodies 'at risk' due to structural alterations. Diffuse pollution is considered to be the primary pressure causing siltation and degrading of fish spawning sites. Siltation and shoaling of coarser material can compromise flood capacity and is common where channel dimensions have been increased, a hydromorphic assessment is needed to ensure WFD compliance. In-stream maintenance activities have the potential to disturb spawning gravels at a number of sites. Floodplain and coastal habitats are linked to river dynamics and must be considered during maintenance planning, flood alleviation and engineered structure design. Regardless of the rate, channel maintenance will impact directly on water quality and flood risk by potentially altering the conveyance potential of the channel. Hydromorphological pressures are relevant in relation to potential impacts on benthic invertebrates and fish populations, but the link between these pressures and ecological status in Irish waters needs further investigation. In-channel maintenance work can also lead to hydromorphological issues in the waterway, for example, the work can often reduce the roughness of the river bed resulting in enhanced conveyance. If the channel is not connected to the floodplain, the water volume will increase, resulting in more extreme flood peaks and potential flooding downstream. In-channel maintenance works can release entrapped nutrients in the sediments which may become available to the water bodies. Nutrients of particular concern would be nitrogen and phosphorus both of which are limiting nutrients and are associated with eutrophication in estuaries and freshwater respectively.
Soils & Geology	Natural flood storage, attenuation and conveyance areas on floodplains including wetlands, should be considered in light of the impact on soil conditions and sediment regimes. Depending on the location drainage maintenance activity could be of benefit or detriment to soil conditions. Extensive and intensive land drainage in both the uplands and lowlands can increase the speed at which water reaching the land surface (from precipitation) is then transported to the main arterial networks and discharged downstream to potentially threaten flood risk receptors (people and property). Certain inappropriate and untimely land management practices, especially on more sensitive soil types, can contribute to a reduction in the infiltration of water into the soil and an increase in rapid surface runoff (e.g. clearing of riparian vegeration on river banks). Appropriately managed pasture, rough semi-natural vegetation, wetlands (including peat bogs) and forestry/woodland can all assist in the attenuation and storage of rapid surface runoff and floodplain flows upstream of flood risk receptors. The targeted use of appropriate agri-environment scheme agreements could be used for multiple benefits, including flood management and biodiversity enhancement. Natural flood storage and attenuation areas on floodplains including wetlands, should be further protected from development pressures.
Land Use and Land Cover	The extent and intensity of land drainage in both the uplands and lowlands could have an impact on the regime of the waterways, and potentially increase flood risk. Inappropriate land management practices, especially on more sensitive soil types could reduce water infiltration into the soil resulting in an increase of surface water runoff. The management of grassland, semi-natural vegetation, wetlands, and woodlands can assist in the storage of rapid surface runoff and floodplain flows upstream of flood risk receptors. Inappropriate or intensive land-use practices can result in erosion, modification of channel geomorphology, or discharge of receiving sediments. Natural flood storage areas on flood plains including wetlands should be protected from development pressures.

SEA Topic	Threats and Opportunities
	The potential for maintenance activity to ensure sustainability of land-use through the maintenance of an FRS for sustainability of flood risk and maintenance of channels for agricultural productivity. Consideration of maintenance activities for land-use planning.
Air & Climate	Potential for increased fluvial, pluvial, and tidal flooding resulting from climate change. The carbon footprint of activities should be considered during their development. Measures to compensate for the losses of sequestered carbon in the peat and drainage channels should be considered by the OPW.
Biodiversity, Flora & Fauna	A large proportion of the arterial drainage schemes are of high biodiversity interest and value. Many of these are located within or adjacent to Natura 2000 sites, which contain annexed habitats and species and for that reason, appropriate assessments under the Habitats and Birds Directive should be conducted in order to assess if the draft programme will pose adverse impacts to the SACs and SPAs. However, it is still important to conserve, where possible, non-EU designated habitats and species (e.g. riparian vegetation and badgers). Causing negative impacts on sensitive habitat NHAs or pNHAs (ie:peatlands, limestone habitats). Freshwater Pearl Mussel, Atlantic Salmon, lamprey species, and White-clawed Crayfish will be particularly sensitive to pollution and in-channel maintenance works, which may also contradict objectives of the WFD. Changes to the flooding regime river channels and adjacent lands may have impacts on habitats and species which require particular inundations periods or in the case of groundwater dependent ecosystem (e.g. fens) particularly water supply mechanisms and water chemistry. Ensures that potential works do not alter fish spawning and nursery areas. Maintenance activities should not negatively impact or block passages of migratory fish. Riparian areas such as alluvial forests and wetlands, should not be altered, unless there is a significant and demonstrable flood risk, as they provide habitats, support species, and increase biodiversity. The spread of non-native invasive species has the potential to threaten native flora and fauna. Where possible, opportunities to treat and control non-native, invasive species as part of maintenance activities should be taken. Measures such as avoidance of working in areas containing invasive species, and implementing method statements and adopting appropriate biosecurity measures during works will minimise the spread of invasive species. Protect and where possible enhance the integrity of fishery habitat within Arterial Drainage Scheme catchments, Flood Relief Scheme channels and designated channels. Improve methods and processes for managing invasive species and risk of invasive species colonisation, growth, and spread. Maintain or expand habitat supporting salmonid fisheries and carry out enhancement works where possible. Increased flooding has the potential to provide opportunities for enhancement or creation of wetland areas, with associated benefits for the species these habitats support. Changes to the flooding regime can adversely impact upon biodiversity, through nutrient enrichment, detrimental impacts on water quality, siltation and community changes.
Archaeology & Cultural Heritage	Potential to reduce the risk from flooding to existing archaeological and architectural resources, both in historic city centres and to individual sites. Drainage maintenance activities will be constrained by the need to protect the setting of areas of existing archaeological and architectural value e.g. Monuments, Protected Structures, ZAPs, ACAs etc. Specific impacts on known individual sites, monuments and structures, and further consideration of undiscovered archaeological resources will need to be addressed at the pre-works stage. The archaeological potential of all drainage areas should be investigated.
Climate Change	Potential for increased fluvial and coastal flooding resulting from climate change. Increased likelihood of river and coastal flooding. Increased rainfall and sea level influencing the ability of arterial drainage schemes and embankments to function as designed. The release of greenhouse gases because of altering or cutting bog and peatlands and removing

SEA Topic	Threats and Opportunities
	trees. Greenhouse gas emissions from machinery, vehicles and materials used to undertake maintenance activity. For small coastal schemes, sea level rise alone could result in the existing scheme being unable to provide its intended function. It is important to consider how climate change predictions could prompt a change in land-use in order to adjust accordingly. The carbon footprint of activates should be a consideration during their development. Measures to compensate for the losses of sequestered carbon in the peat and drainage channels should be considered long term by the OPW. With a management strategy that allows for adaptive capacity to be maximised, flood protection and land drainage function could be continued into the future. There is also the potential for schemes to provide enhanced flood protection where there is potential significant future flood risk. Protection, conservation and enhancement of existing carbon stores (e.g. peatlands and forest) can offer some contribution to the net carbon budget of the state. This could be achieved through careful planning of maintenance activity to maximise ecosystem conditions. Reduction in greenhouse gas emissions from continual evolution of machinery and vehicle fleet used in drainage maintenance activity. Also an opportunity to consider of the carbon footprint of materials used.

7 SEA Objectives

7.1 Introduction

Section (e) of Schedule 2B of the SEA Regulations requires environmental protection objectives, targets and indicators to describe and monitor change and predict impacts of the proposed Plan or Programme on the environment. SEA uses a combination of environmental objectives, targets and indicators to describe and monitor change and predict impacts of proposed plans and programmes on the environment (Therivel, 2004).

An initial set of environmental objectives was identified during the scoping process. These objectives have been refined based on the replies from the scoping process and the meetings that were held as part of the consultation process and the communications received (see Section 8).

Objectives and targets set aims and thresholds that should be considered when assessing the impacts of the options on the environment. Indicators are used to illustrate and communicate environmental impacts in a simple and effective manner. High level objectives have been identified for a number of relevant environmental topics. These were further divided into more specific sub-objectives relating to each topic. For each topic, a framework of indicators and targets were established.

The performance of the activity was qualitatively assessed for each sub-objective relative to the baseline conditions. If significant impacts were identified, then appropriate mitigation measures were suggested.

7.2 Development of the SEA Objectives

The environmental objectives are derived from International, European and national policies on various aspects of the environment. Many of these policies have been transposed into Irish legislation and are now mandatory and need to be integrated and implemented into spatial planning documents and programmes.

An initial set of environmental objectives were proposed in the Scoping Report. As mentioned these were further refined following on from the scoping consultation stage. The list of environmental objectives used in this report is based on the environmental topics set out in Paragraph F of Schedule 2B which is contained in the SEA Regulations which might be significantly impacted upon by the Drainage Maintenance Activities. These include:

- biodiversity (flora & fauna)
- population/human health
- geology/soil
- water
- air/climatic factors
- material assets
- cultural heritage
- landscape
- and the interrelationships between these factors.

The concept of the objectives is that they can form a set of performance reporting criteria for arterial drainage maintenance, as well as a robust set of objectives for repeat assessments. All objectives must be measurable, strategic and not tactical, and something arterial drainage maintenance has an influence upon. The objectives will form the basis of on-going monitoring of all the drainage maintenance activities and the proposed indicators will be used to assess achievement of these objectives. It is recommended that the OPW, as part of their annual drainage assessment, reviews the findings of the previous year's maintenance activities and where non-compliances or non-performances are identified, revised SOPs or operational practices are put in place. Subsequent auditing of the environmental objectives will identify the success or otherwise of the improved measures. This will be 'continual environmental

improvement' and while the OPW does not have a recognised Environmental Management System (e.g. ISO:14001), the concept of continual improvement is favourable.

The objectives are similar to outcome measures reported by the Environment Agency on a quarterly basis and the CFRAM Flood Risk Management objectives.

For the five-year arterial drainage maintenance programme to be sustainable it must:

- Balance positive and negative environmental, social, economic and cultural heritage impacts. It may be appropriate to weight each objective for relative importance and the impacts of the proposed programme and alternatives should be compared.
- Be cost effective and an optimal use of public funds. It is unsustainable to allocate public funds where there is insufficient return on investment or the returns are not being realised
- Have no long-term impact on the most sensitive environmental indicators. The importance of irreversible impacts in relation to the Habitats Directive, WFD and cultural heritage must be considered.
- Ensure that the quality of life for the public is supported and that the risk of flooding or flood damage arising is minimised.
- Reduce climate change impacts and contribute to climate change mitigation.
- Allow for adaptation to future climate change.
- Social and economic importance of agricultural productivity and flood reduction being intertwined with channel maintenance.

7.3 Internal compatibility of the SEA Goals

The internal compatibility of the SEA goals has been examined to identify potential areas of consistency and conflict between them, so that subsequent decisions can be firmly founded. For example, the goal to improve water quality is consistent with enhancing biodiversity and protecting human health. In some cases, there is no obvious relationship between the objectives, such as no direct link between improving soil quality and influencing climate change. However, there may be some conflict between material assets, landscape and soils. This is because for example the removal of sediment form a channel during maintenance will result in the removal of soils and could potentially cause a visual impact. In respect of these conflicts mitigation measures will be suggested in this Environmental Report.

Table 7-1. SEA environmental objectives, sub-objectives, indicators, targets and aspiration targets.

Aspect	Objective	Sub-objective	Target (Minimum) timescale in italics	Indicator	SEA Topic
Environmental (Water)	Support the objectives of the Water Framework Directive (WFD).	Enhance natural fluvial processes in support of WFD objectives, through delivery of new, and maintenance of existing, EREP and other river restoration works that are part of the arterial drainage maintenance programme.	Improved biological status and hydromorphological conditions of all arterial drainage channels influenced by EREP and other river restoration works.	Biological status and hydromorphological conditions of channels influenced by EREP and river restoration works (both new and existing EREP projects).	Flora, Fauna & Biodiversity, Water (Hydromorphology)
		Provide no impediment to the achievement of water body objectives and contribute to the achievement of water body objectives.	Provide no constraint to the achievement of water body objectives during and beyond this 6-year maintenance period.	Numbers of water bodies, with connectivity to channels, embankments and flood relief schemes, maintained within the 6-year Arterial Drainage Maintenance period failing to achieve GES/GEP due to hydromorphology. (indicator is designed to remove other variables which influence water body status, and focus on hydromorphology which is strongly linked to arterial drainage maintenance and historic channel works)	
		Ensure water quality remains adequate to support a healthy aquatic biological community and that it meets environmental standards established for general physiochemical conditions and specific pollutants of concern.	Ensure no deterioration of physiochemical conditions or an increase of specific pollutants of concern, maintain adequate biological environment in the rivers and channels. Ensure that dissolved oxygen levels remain at acceptable levels.	Ecological and chemical status of rivers and channels influenced by maintenance activities (on channels, embankments and flood relief schemes) that are part of the Arterial Drainage Programme.	
Environmental (Flora, Fauna & Biodiversity)	Protect the flora and fauna within the river, river corridor and along vehicular access points and where possible enhance biodiversity.	Support the objectives of the EU Habitats and Birds Directives by avoiding detrimental effects to, and where possible enhance, Natura 2000 network, protected species and habitats.	No deterioration in the conservation status of designated sites screened in for Appropriate Assessment (level 2 Natura Impact Statement) as a result of maintenance activities on channels, embankments and completed flood relief schemes during and beyond this 6-year maintenance period.	Annual change in conservation status of designated sites screened in for Appropriate Assessment (i.e. Arterial Drainage channels and embankments which require level 2 Natura Impact Statement of maintenance activities). Loss of, or significant changes to habitat of, priority habitats and species where Arterial Drainage Schemes have the greatest impact or where significant proportion of the annexed habitats or species are located in the proximity to Arterial Drainage scheme catchments,	Flora, Fauna & Biodiversity

Aspect	Objective	Sub-objective	Target (Minimum) timescale in italics	Indicator	SEA Topic
				channels or embankments.	
		Avoid damage to, and where possible enhance, legally protected sites/habitats and species of national, regional and local conservation importance.	No deterioration in the conservation status of designated sites as a result of maintenance activities on arterial drainage schemes, embankments or flood relief schemes during and beyond this 6-year maintenance period.	Reported changes in population sizes and/or areas of suitable habitat maintained or created for target species.	Flora, Fauna & Biodiversity
		Protect existing riverine, wetland and peatland habitats to maintain naturally functioning ecosystems and hydromorphological conditions.	Protection or enhancement of existing habitats during and beyond the 6-year maintenance period.	Support delivery of the National Peatlands Strategy. Area of habitat/length of river & river corridor enhanced through implementation of maintenance programme activities.	Flora, Fauna & Biodiversity, Water (Hydromorphology)
		Protect, and where possible enhance, hedgerows and woodlands within the riparian corridor.	No net loss of hedgerow and woodland within the riparian corridor during and beyond the 6-year maintenance period.	For channels, embankments and flood relief schemes programmed for maintenance works, the lengths of hedgerow and woodland within the riparian corridor removed, created or re-established	Flora, Fauna & Biodiversity, Water
		Minimise the risk of spread of any invasive aquatic or terrestrial species.	No increase in the spread of invasive aquatic species during the 6-year maintenance period.	Length of arterial drainage river corridor affected by invasive species.	Flora, Fauna and Biodiversity (Fisheries)
Environmental (Fisheries)	Protect and, where possible, enhance the integrity of fisheries within the Arterially Drained catchments.	Maintain existing habitat supporting salmonid fisheries and carry out enhancement where possible.	No decrease in area or detriment to existing salmonid habitat as a result of maintenance activity during and beyond the 6-year maintenance period.	Areas of suitable habitat supporting salmonid fisheries. IFI assessments on biodiversity and hydromorphological improvements following river enhancement works.	Flora, Fauna and Biodiversity (Fisheries)
		Ensure no adverse effects on commercial shellfisheries.	No deterioration in existing EPA classification due to upstream maintenance activity during and beyond the 6-year maintenance period.	EPA classification of shellfish waters.	Flora, Fauna and Biodiversity (Fisheries)
Environmental (Climate Change)	Minimise the climate change impacts of Arterial Drainage maintenance activities	Reduce greenhouse gas emissions from machinery and equipment used in Arterial Drainage maintenance activity	To operate machinery with low carbon emissions Annual reduction in greenhouse gas emissions from machinery and other arterial drainage maintenance activities.	CO2 emissions from machinery, plant and vehicles. Can be inferred from emissions estimates, duration of operation or mileage.	Climate change
		Minimise release of sequestered greenhouse gases from sinks such as peatlands and forests.	No release of sequestered greenhouse gases during this 6-year maintenance period.	Area of peatland drained. Area of forest soils drained. Tonnes of greenhouse gases (CO2	Climate change

Aspect	Objective	Sub-objective	Target (Minimum) timescale in italics	Indicator	SEA Topic
				equivalent) emitted versus tonnes of greenhouse gases sequestered	
	Adaptation to climate change	Performance of arterial drainage scheme channels, embankments and flood relief schemes over time.	Monitoring and assessment of asset performance and condition informs asset management and maintenance plans. Allocation of resources is optimised to benefits and risks.	Conveyance capacity (in % AEP) of Arterial Drainage Scheme Channels. Standard of Protection of embankments and flood relief schemes. Asset condition to indicate risk of failure of channels, embankments and flood relief scheme elements.	Climate change
		Adaptive capacity[6] of ongoing maintenance activities to current and potential future demands.	Maintenance activity does not restrict the adaptive capacity of arterial drainage channels, embankments and flood relief schemes in relation to climate change scenarios and uncertainty. Maintenance activity is no-regret[7] or low-regret, in that it does not restrict adaptation of catchments and watercourses to future demands or changes: - Reduce potential for irrigation and increased abstraction. - Reduce potential of receiving waters for discharges. - Restrict potential for natural flood management or other flood management measures. - Reduce adaptive capacity for changes in agricultural practice.	Measure of adaptability (performance of existing assets) under climate change scenarios.	Climate change
Social	Public access and recreation	Avoid negative impacts to existing water-based leisure activities.	Maintain level of existing water-based leisure activities during this 6-year maintenance period.	Level of compliments/ complaints from Community Councils and concerned residents or their spokesperson.	Material Assets (Tourism & Recreation)
	Contribute to viable and sustainable local communities	Contribution to health and wellbeing of local communities including local employment	TBC	No. of people living in benefitting lands. Proportion of vulnerable people (elderly,	Population & Human Health

[6] The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities and to cope with the consequences. (CLIMATE-ADAPT Glossary)

[7] 'No-regret' measures are whorthwhile now (in that they would deliver net socio-economic benefits which exceed their costs) and continue to be whorthwhile irrespective of the nature of future climate change. (EC non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient)

Aspect	Objective	Sub-objective	Target (Minimum) timescale in italics	Indicator	SEA Topic
				young and in poor health) residing within benefitting lands. No. of hospitals, nursing homes, residential homes, schools and local community facilities in benefitting lands. No. of commercial, industrial and agricultural enterprises in benefitting lands.	
		Maintain access to local services and transport networks up to the design standard of protection.	No road flooding in benefitting lands to the current standard of protection of Arterial Drainage Schemes (between the 50% and 20% AEP) during this 6-year maintenance.	Length of local roads within benefitting areas. Number of local roads flooded annually. Number of local roads impassable by car.	Population & Human Health
Economic	Avoid damage to, and where possible improve, the function and quality of the soil resource.	Maintain soil quality and function for productivity on agricultural lands.	No reduction in average agricultural yield in benefitting lands over this 6-year maintenance period.	TBC	Soil & Land-use
	Support agricultural activity without conflicting with environmental objectives.	Maintain lands available for economic activity and no change as to render existing economic activity unviable.	Maintain benefiting lands at current economic activity potential. No flooding of agricultural land in benefitting lands to the current standard of protection of Arterial Drainage Schemes (between the 50% and 20% AEP) during 6-year maintenance period.	Area of agricultural land in benefitting land. Area of agricultural land in benefitting lands flooded annually.	Material Assets
Cultural Heritage	Protect known features of cultural heritage.	Protect archaeological features listed on the Record of Monuments and Places (RMP) and other listed National Monument and Archaeological Sites, Protected wrecks, archaeological objects and world heritage sites.	No detrimental impact upon architectural features as a result of arterial drainage maintenance activities during and beyond this 6-year maintenance period.	No. of architectural buildings and structures listed on the RPS and ACAs within zone of influence of the 5-year maintenance programme (per year). No. of architectural buildings and structures listed on the RPS and ACAs with impact assessments prior to maintenance works.	Cultural Heritage (Architectural and Archaeological Heritage)

Aspect	Objective	Sub-objective	Target (Minimum) timescale in italics	Indicator	SEA Topic
		Protect archaeological features listed on the Record of Monuments and Places (RMP) or other listed National Monument and Archaeological Sites.	No damage to or loss of features listed on the RMP as a result of Arterial drainage maintenance works during and beyond the 6-year maintenance period.	Numbers of archaeological features registered on the RMP within the zone of influence over this 5-year maintenance period (per year) No. of RMPs with archaeological assessment prior to maintenance works.	Cultural Heritage (Architectural and Archaeological Heritage)
	Protection of unknown features of cultural heritage	Protect undiscovered archaeological features.	Maintenance activity causes no detrimental impact upon or loss of unknown cultural heritage features during and beyond this 6-year maintenance period.	Percentage of arterial drainage channel reaches or embankments in peatlands, estuaries or through towns in maintenance programme with archaeological impact assessment screening study.	Cultural Heritage (Architectural and Archaeological Heritage)

8 Consultation

8.1 Introduction

A Strategic Environmental Assessment (SEA) is required for the National Arterial Drainage Maintenance Activities (2016-2021). The Scoping Report was conducted to ensure that all relevant environmental issues were identified so that they could be adequately addressed in the Environmental Report. In accordance with Article 13(1) of the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 (as amended) (SI No. 435 of 2004), JBA on behalf of the OPW gave notice to the environmental authorities specified in the Regulations.

In accordance with the Aarhus Convention, the public and other interested stakeholders were involved in the decision making for the National Arterial Drainage Maintenance Activities 2016-2021.

8.2 Project Website

The project website for the OPW National Arterial Drainage Maintenance Activities 2016-2021 has been set up as a portal for information to be disseminated at various stages of the project (http://www.opw.ie/en/floodriskmanagement/operations/environmentalactivities/). To date there has been one document uploaded and made available on the website:

- National Arterial Drainage Maintenance Activities 2016-2021 Strategic Environmental Assessment (SEA) Scoping Report.

8.3 Formal Consultation

The SEA scoping consultation phase on the draft Arterial Drainage Maintenance List of Activities (2016-2021) SEA Scoping Report took place from 17th June 2016 until July 17th 2016.

The Scoping report was sent to statutory and non-statutory stakeholders, as well as, publicised on the OPW project website (mentioned above).

8.3.1 Statutory Consultees

The SEA Scoping Report was issued to primary and secondary stakeholders and environmental authorities on June 17, 2016.

The Environmental Protection Agency (EPA), National Parks and Wildlife Services (NPWS), and Inland Fisheries Ireland (IFI), all provided comments which were recorded and acknowledged, where appropriate changes were made.

There was one SEA stakeholder meeting held during the SEA Scoping Stage:

- SEA - Stakeholder meeting 1 (30 June, 2016) - OPW and EPA attendees

8.3.2 Non-Statutory Consultees and Stakeholders

Throughout the Arterial Drainage Maintenance Activities 2016-2021 SEA scoping process and formal consultation feedback was received from local authorities, regional and national organisations such as the ICMSA (Irish Creamery Milk Suppliers Association): The Family Farm Organisation and TII (Transport Infrastructure Ireland). All comments and suggestions provided were recorded and acknowledged, where appropriate changes were made.

All reports have been issued to the OPW, statutory, and non-statutory consultees.

8.3.3 Response to Submissions

All submissions (responses, comments, and recommendations) were acknowledged and recorded in a summary table (See Table in Volume IV: Appendix A). The responses were also included in the environmental report in sections relevant to its context. The summary table highlight the main focus of the response and acknowledges the particular section where each point will be addressed. The majority of submission's comments and recommendations are addressed in the following sections of this SEA report:

- Programme Description
- Current Environmental Status
- Assessment
- In-combination
- Mitigation/Planning
- Monitoring

9 Alternatives Considered

9.1 Introduction

This section discusses the alternatives that have been considered for the maintenance activities. The JBA project team has followed the EPA guidelines for the assessment of alternatives in Strategic Environmental Assessment. The key consideration for the Arterial Drainage Maintenance Activities 2016-2021 is that the alternatives proposed and assessed must be technically viable and within existing Arterial Drainage Act legislation. The current approach is unlikely to be significantly changed as this would require an amended or new Arterial Drainage Act legislation. There are however potential alternatives within the scope of the Arterial Drainage Acts. All of the recommended mitigation measures proposed in this SEA comply with the current legislation, however some of the follow on findings or changes may require updates to legislation in the future.

9.2 Alternatives Considered

9.2.1 The 'Do Nothing' Alternative

This is not a viable alternative due to Arterial Drainage Act legislation and will not be assessed.

9.2.2 Do minimum

It is plausible that unforeseen circumstances in the next six- years may result in the situation where funding for Arterial Drainage maintenance is cut. An indicative cut in funding by 50% will be assessed and used to evaluate the impacts of a reduced maintenance regime.

With such a reduction in funding there are both positive and negative outcomes in relation to the proposed activities, both of which could occur on the same catchment or even at the same location. The do minimum alternative will more than likely result in more negative impacts than the proposed activities. This is because the reduced funding is most likely to be targeted at maximising the coverage of maintenance activities each year and not allocated to monitoring or changes to planning and onsite activities and approaches.

9.2.3 Do existing

This is the same as the proposed activities, which are no change from current practise.

JBA has carried out a desktop assessment for a number of alternatives that was considered for this SEA. The full assessment is presented in Volume IV: Appendix E and the main findings of the assessment are discussed below. The alternatives are assessed against the current maintenance activities.

9.2.4 Alternative 1 – an evolved approach to the selected preferred method activities

This alternative would be the implementation of changes in the planning, supervision and details of activities and mitigation. These changes are to improve both the planning and application of arterial drainage maintenance activities in the following areas:

- M1- Improved maintenance planning (6-year and annual plans),
- M2- Improved Standard Operating Procedures and Environmental Protocol,
- M3-Monitoring of all maintenance activities with continuous improvement through feedback into methods and approach,
- M4-Expansion of river restoration and environmental enhancement
- M5-Assests Management and Climate Adaptation Planning
- M6-Monitoring of environmental conditions.

Under Alternative 1 more positive impacts are expected for most of the objectives. As there is no reduction or enhancement in the benefit of arterial drainage schemes, there is no change to the impacts upon some of the social and economic objectives.

This evolved approach to the current activities does allow for planning in advance of the works which will enable environmental constraints to be identified at an early stage and appropriate mitigation measures put in place. This in turn would assist in the provision of more protection of the habitats and species while still meeting the requirements of the Arterial Drainage Act. Water quality would also be maintained which would ensure compliance with the WFD objectives. Overall Alternative 1 would support the environmental objectives for water, flora, fauna and biodiversity, fisheries, climate change, economics and cultural heritage.

Pre-planning would also involve the provision of an archaeological desktop assessment to determine the archaeological potential of the sites in question.

The natural flood management options would require sufficiently more detail and planning. Site selection would be constrained by the presence of Annex 1 habitats, SAC, NHA or SAC's. Current land uses, compensation etc. would all need to be considered for some of the natural flood management options. Depending on the size and extent of the natural flood management option and environmental impact assessment and NIR may be required. The OPW could start investigating this alternative for future activities.

9.2.5 Alternative 2 – different methods to achieve the objective of Arterial Drainage Maintenance

This alternative is based upon the application of different methods to achieve the same objectives. This would include:

- M2- Improved Standard Operating Procedures and Environmental Protocol,

Improved standard operating procedure and environmental protocols are focused on aiming to address concerns from stakeholders on the methods and approaches of specified maintenance activities. The intention of these recommendation is to further facilitate good environmental practices. These should be considered as continual improvement of existing procedure as opposed to new extra procedures.

Under Alternative 2 more positive impacts are expected, however this alternative would be expected to support fewer objectives than Alternative 1. This is because no changes to the planning of maintenance activities are included in this alternative. The current planning approach and systems will remain. Under this alternative, the approach to, and carrying out of maintenance activities in the field will change.

The assessment of this alternative is a limited improvement above current operating procedures and less environmentally effective than Alternative 1.

9.2.6 Alternative 3 – modification of Arterial Drainage Schemes

Alternative 3 is to change the form and function of arterial drainage schemes. This could range from walking away from some schemes, broader catchment scale environmental enhancements and natural flood management (e.g. forestry, restoring natural floodplains, runoff storage).

The application of Alternative 3 for each catchment cannot be determined at present and so the potential impacts are highly uncertain. It is likely that the benefit of arterial drainage schemes to rural communities and agriculture would reduce. The level at which benefits would be impacted and the compensatory measures applied to manage this cannot be determined at this stage.

9.2.7 Summary of Alternatives

In summary, the assessment of alternatives shows that improvements to the planning, methods and monitoring of arterial drainage maintenance activities would result in more positive impacts than the proposed activities. These will be addressed in this SEA through a set of recommended mitigation measures. Volume IV: Appendix C contains a table summarising the possible change in impact with the alternatives in place.

10 Evaluation of the Impacts of the Proposed Arterial Maintenance Activities

10.1 Summary of the Assessment of the Activities

This chapter of the Strategic Environmental Report assesses the likely significant environmental impacts of implementing the Arterial Drainage Maintenance Activities 2016-2021 on a catchment level and nationally.

This assessment of the activities has been carried out at a strategic level and the predicted impacts are based on the current information available. The maintenance of flood relief schemes, structures or new drainage schemes not covered in Table 3-1 are not assessed.

The selection of maintenance activities for specific channels, embankments and structures (the 6-year and annual maintenance programmes), and the actual maintenance undertaken will be assessed at the project level, when more specific local impacts will be identified and assessed. At this level, local information will be captured and a more quantitative assessment of the impacts and suitable mitigation measures can be undertaken.

The impacts of the proposed Arterial Drainage Maintenance Activities 2016-2021 have been assessed for all catchments which contain an Arterial Drainage Scheme, Land Commission Embankment or Flood Relief Scheme with maintenance responsibilities under the Arterial Drainage Acts. Volume IV: Appendix D contains the catchment-wide assessment tables and the maps in Volume IV: Appendix E show the catchments where maintenance activities will be undertaken. The catchment approach reflects the catchment planning approach recommended by the EPA during the consultation on the Scoping Report and is a further step towards aligning the integrated planning of maintenance activity with land and catchment management. The upcoming publication and adoption of Flood Risk Management Plans at Unit of Management level will enable land drainage, flood protection and coastal protection to be considered holistically. This assessment is indicative and for catchment scale planning will need to be refined and informed by catchment scale planning tools such as those presented in the REFORM programme.

Due to the strategic nature of SEA, JBA undertook a qualitative assessment of the Maintenance Activities against the environmental objectives. As previously mentioned a more detailed quantitative assessment will be undertaken as part of the environmental assessment that will be required for planning and undertaking the maintenance activities.

Where a significant impact was identified during the assessment mitigation measures to remedy same were identified. Opportunities (positive impacts that could achieve the aspirational targets) were also identified during the process

The following marking system was used in our assessment tables to illustrate the impacts, duration and extent of the impacts on the environment.

Major +ve	√√√
Moderate +ve	√√
Minor +ve	√
Neutral Impact	0
Minor -ve	X
Moderate -ve	XX
Major -ve	XXX
Uncertain	????

Duration of Impact

<1 yr	T
1-7 yrs	ST
7-15 yrs	MT
15-60 yrs	LT
> 60 yrs	P

Extent of Impact

Sub-Catchment	L
Catchment	R
River Basin	N

Our assessment has found that the impacts on the catchments tend to be very similar. The impacts of maintenance activity are more localised in catchments with smaller schemes or where benefitting lands only cover part of the catchment. The distribution of EREP schemes, shellfish and salmonid waters is not evenly spread across the catchments and this drives some of the differences in environmental impact

ratings. Consequently, the mitigation measures for some of the catchments may vary depending upon the sensitivity of the waterbody and the species contained therein.

The social and economic scores are strongly linked to the population distribution and the proportion of the catchment classified as benefitting lands. More significant positive social and economic benefits are found in dispersedly populated rural catchments than more urban catchments. This is because the maintenance of drainage schemes affects a greater proportion of the population and economic activity within these catchments. In urban areas, there are numerous alternative roads and a more varied economy not dependent upon land drainage.

In some catchments, such as Galway Bay South East, there are only two very localised Flood Relief Schemes (Gort and Lackan Flood Relief Schemes) subject to the Arterial Drainage Maintenance Activities 2016-2021. The impacts of the OPW maintenance activities have been assessed. Within this catchment there are significant drainage districts maintained by Galway County Council and others. The impact of these in combination with the OPW maintenance activities is assessed in Section 10.3.

The proposed activities have been assessed against the environmental objectives given in Section 7. The assessment tables for each of the catchments are presented in Volume IV: Appendix D. These tables show the potential impacts of the activities on the specific conditions of the catchment as described in Section 6. A summary of the general and in some cases catchment specific impacts under each objective are described in Section 10.2 below. The tables also include an assessment of the potential impacts of the maintenance activities with recommended mitigation measures employed. These are described further in Section 11. The summary of the impacts in Section 10.2 is based purely on the description of the Arterial Drainage Maintenance Activities 2016-2021 (as included in Volume III: Arterial Drainage Maintenance Activities 2016-2021 SEA Natura Impact Statement). This assessment may appear unduly negative, and in many cases the OPW is working towards higher standards and looking to improve processes, methods and the general approach to maintenance activities. As these are not fully established they are not included in the impact assessment of the activities as described. The impact of maintenance activity with these, and other improvements, when fully implemented and effective is represented in the residual impact assessment. Examples of such improvements already in progress include:

- additional mitigation measures within Appropriate Assessment Screening and Natura Impact Statement reports,
- development of pilot approaches to tree management in sensitive locations,
- targeted ecological surveys before EREP scheme works commence,
- development of GIS systems and data sharing with field operatives,
- development of environmental risk registers.

At the time of the implementation of the Habitats Directive [92/43/EEC], the EU Birds Directive [2009/147/EC] and the Water Framework Directive [2000/60/EC], Arterial Drainage Schemes (channels, embankment, and flood relief schemes) were already introduced around the country. The baseline conditions at the time of the implementation of the above directives reflected already drained catchments and ongoing maintenance of such schemes.

10.2 Summary of potential impacts

The discussion in the following section of this SEA provides text on the predicted impacts of the activities on the environment that is presented in the tables. The predicted impacts are based on the professional judgments made by the SEA team based on our current knowledge.

10.2.1 Objective A Environmental (Water): Support the objectives of the Water Framework Directive (WFD)

Sub-Objective A1: Enhance natural fluvial processes in support of WFD objectives, through delivery of new, and maintenance of existing, EREP and other river restoration works that are part of the arterial drainage maintenance programme.

With the exception of a small number of schemes our assessment has predicted a minor negative impact on the objective relating to the supporting the WFD objectives. Our assessment has concluded that, in the absence of suitable mitigation measures, this impact will be local and will be typically be of medium term duration (6-years). Any maintenance activity that involves dredging or in-channel works will cause increases in suspended solids and nutrients. It is estimated that in general this will be a short-term local impact. Longer term impact may arise due to changes in the hydromorphology of the channel and the receiving waters. In the long-term the quality of water may also deteriorate due to increases in nutrient loadings to the water bodies. Nutrient loading in excess of the waters assimilative capacity may result in eutrophication of the waster body. This would decrease the water quality and impact on the biodiversity of the water. Our assessment has identified several mitigation measures that will reduce/remedy these impacts.

EREP projects enhance fisheries habitat locally, with some cumulative benefit of multiple schemes on the same watercourse and catchment. As the benefit of EREP projects are local only and the remainder of the catchment can be subject to the full range of maintenance activities there is an overall potential negative impact. The impact of the Arterial Drainage Maintenance Activities 2016-2021 at the catchment scale, for catchments that contain EREP schemes, in general have been assessed as having a minor positive significance, with medium term duration and local extent. Where there is a high proportion of channels within a catchment covered by EREP schemes (for smaller catchments with existing or proposed EREP schemes, or larger catchments with multiple EREP schemes) the positive impact of EREP works at the catchment scale is likely to be greater.

In schemes, for example the Ballyteigue/Kilmore Arterial Drainage Scheme in the Ballyteigue-Bannow Catchment, where there are no EREP schemes, it is estimated that mitigation measures as suggested will help to alleviate the impacts and will help to support the WFD objectives.

Under the description of the Arterial Drainage Maintenance Activities 2016-2021 there is no scope for further river restoration or environmental enhancements outside of the EREP programme. However, the OPW in partnership with the DAHRRGA are involved in a pilot Conservation Management Plan for a fen SAC, including specific examination of the implications for drainage. The Tory Hill Fen SAC (0439) was chosen as the pilot site, which also has arterial drainage channels. The aim is to produce a Conservation Management Plan for the SAC which sets out measures for maintaining or restoring favourable conservation status.

In future, hydromorphological processes will be considered in restoration efforts rather than only individual features as is current done by the River Hydromorphology Assessment Technique (RHAT) previously used by the EPA, because if processes (rather than stagnant features) are not reinstated, the ability of the waterbody to become self-sustainable will be limited (Quinlan, 2015). The measure of Morphological Quality Assessment (MQI) originally developed in Italy (Rinaldi et al, 2012) is being adapted to satisfy Irish requirements and will be used for hydromorphological assessment when completed (Quinlan, 2015). A better understanding of hydromorphological processes will assist in the prioritisation of waterbodies and appropriate management of hydromorphological issues in the country.

Sub-Objective A2: Provide no impediment to the achievement of water body objectives and contribute to the achievement of water body objectives.

The current Standard Operating Procedures and Environmental Protocols reference the WFD River Basin Management Plan objectives, in that some of the approaches within the Environmental Drainage Maintenance Guidance Notes allow for maintenance activity to contribute to achieving good or high ecological status. Future development of standard operating procedures and environmental management protocols could incorporate the WFD requirements further.

The planning for maintenance activities does not include a WFD or hydromorphological audit and so it is possible for the maintenance activities to result in moderate negative impacts, which could be long term and at the regional scale. Medium term impacts could arise from inappropriate application of maintenance activities with moderate recovery times such as removal of continuous mature woodland, which shades watercourses. Unclear specification of silt removal could also degrade a channel and result in long term changes to hydromorphology upstream and downstream of the maintenance location. Further ecological indicators of water quality status such as macroinvertebrates and fish can be impacted with long recovery times.

The hydromorphological risk assessment in the last WFD cycle had a high level of subjectivity as only one variable (channelisation) was used to assess whether a river body was at risk rather than all hydromorphological modifications needed to make a complete diagnosis of a river condition. The threshold percentage of channelisation for a river to be considered at risk was changed from 15% to 50%, as the initial threshold was considered to be too conservative and rivers were believed to be capable of recovery post-channelisation (Quinlan, 2015; Freshwater POMS, 2008a). The output from the proposed hydromorphological risk assessment was not confirmed in the field and therefore the extent of impact of arterial drainage through channelisation still remains uncertain (Quinlan, 2015). The EPA Catchment Science and Management Unit are investigating hydromorphological characterisation assessment tools adapted for Ireland (ie:Morpholoqical Quality Index (MQI)). Continued scientific development in this field must be closely followed as improved hydromorphological assessment tools are being developed.

Sub-Objective A3: Ensure water quality remains adequate to support a healthy aquatic biological community and that it meets environmental standards established for general physiochemical conditions and specific pollutants of concern.

The current Standard Operating Procedures and Environmental Protocols do not explicitly reference the WFD ecological and chemical status, however some of the approaches within the Environmental Drainage Maintenance Guidance Notes do allow for maintenance activity to contribute.

In relation to pollutants, the standard operating procedures do allow for control of pollution from machinery. Preserving a reduced frequency of flooding to agricultural land as a result of maintenance activity has the potential to reduce the risk of diffuse agricultural pollution (e.g. nitrates and phosphate loading) of watercourses. Preserving the land drainage function reduces the potential for standing water on agricultural land to become contaminated with nitrates or phosphates. The overall positive impact is a reduction in the likelihood of eutrophication of streams, rivers and estuaries.

The scale and duration of impacts on each catchment are similar to those under sub-objective A2. The significance for most catchments is a minor negative impact due to the potential of maintenance activity in reducing agricultural based diffuse pollution. As previously mentioned in Sub-Objective: A-2, the extent of the potential impact of arterial drainage channelisation and maintenance activities is subjective. Better assessment tools are being developed.

10.2.2 Objective B Environmental (Flora, Fauna & Biodiversity): Protect the flora and fauna within the river, river corridor and along vehicular access points and where possible enhance biodiversity.

Sub-Objective B1: Support the objectives of the EU Habitats and Birds Directives by avoiding detrimental effects to, and where possible enhance, Natura 2000 network, protected species and habitats.

The impacts of the maintenance activities on flora/fauna and biodiversity is dependent upon the environmental receptors contained within those catchments. The presence of protected species such as the freshwater pearl mussel, lamprey and salmonids requires a high level of protection and suitable mitigation measures to reduce/eliminate any impacts. Protection of the habitats that supports these species is also vitally important. The appropriate assessment (AA) process for the Arterial Drainage Maintenance Activities 2016-2021 will follow the current process. Recent appropriate assessments have been informative in identifying potential impacts in relation to the EU Habitats and Birds Directives. To avoid or mitigate potential impacts, additional environmental measures have been required. This suggests that the method statements and mitigation measures as detailed in the Arterial Drainage Maintenance Activities 2016-2021 are insufficient in managing the impacts, upon Habitats Directive Annexed species and habitats. In practise these are managed through implementation of the avoidance and mitigation measures listed in the appropriate assessments (AA). Moderate negative, long term and catchment wide impacts are predicted based on the strict application of the activities described. The significance and duration relates to the number of, recovery, and potential for impact upon priority habitats such as turloughs, raised and blanket bogs present within many catchments subject to maintenance activities. Ireland contains significant proportions at the European scale of these habitats and so impacts could potentially be realised at the international scale.

Sub-Objective B2: Avoid damage to, and where possible enhance, legally protected sites/habitats and species of national, regional and local conservation importance.

Many of the national and regional conservation designations relate to peatland and wetland ecosystems. Many of these contain channels and embankments within the scope of the Arterial Drainage Maintenance Activities 2016-2021. Freshwater Pearl Mussel are an example of a species of national conservation interest and critically endangered in Europe.

The assessment of the impact under this objective is similar to sub-objective B1 for most catchments. A quantitative link between hydrological degradation and ecological response subjective and it is currently being investigated. It is understood that the natural functioning of physical processes will support ecosystem diversity and functioning (Quinlan, 2015 and Rinaldi et al, 2013).

Sub-Objective B3: Protect existing riverine, wetland and peatland habitats to maintain naturally functioning ecosystems and hydromorphological conditions.

The planning process for determining what maintenance activities are specified for channels and embankments does not currently take account of the hydromorphology of that river reach or embankment system. Action 15 of the recently published peatlands strategy (NPWS, 2015) has not yet been fully incorporated into the planning and delivery processes for maintenance activities. As the Tory Hill Fen Pilot Study is still ongoing, the action states:

> *"The Office of Public Works, in co-operation with the Department of Arts, Heritage and the Gaeltacht will progress a pilot Conservation Management plan for a fen SAC, including specific examination of the implications for drainage. The pilot site is Tory Hill Fen SAC and the objective is to achieve site specific management plan which sets out the measures for maintaining or restoring favourable conservation status of the qualifying interests".*

Tory Hill Fen SAC - Pilot Study

This Fen action followed consultations between OPW and NPWS where it was discussed that Ireland needs to progress the management plan process for fens. The OPW carry our statutory drainage maintenance in or around a number of peatland SACs, hence have associated requirements around the Habitats Directive, and with NPWS wish to promote the idea of Ireland developing site specific management plans for all these peatland areas, which will have many advantages. The idea is to take one Fen SAC as a starting point and the current OPW / NPWS decision is to use Tory Hill SAC No. 0439 as the pilot site, which has arterial drainage channels, is relatively confined and has a limited number of other non-fen qualifying interests, thereby reducing the complexity for a pilot management plan.

The ultimate objective is to produce a site specific management plan for Tory Hill SAC which set outs the measures for maintaining or restoring favourable conservation status of the qualifying interests. For this first phase, the management plan will be more of a pilot drainage management plan getting to the stage where the drainage implications of any statutory maintained channels are understood and decided as to what extent these can be maintained whilst achieving favourable conservation status of the fen habitat. However, it is expected that the information and understanding collected for this, will be sufficient to develop the full management plan. At that stage, the OPW envisage NPWS moving to consultation of other non-drainage stakeholders to get buy-in for the Tory Hill SAC management plan.

There are further actions in the strategy that will require some form of adjustment in the approach to maintenance activities in relation to peatland and wetland ecosystems.

The potential impact of the Arterial Drainage Maintenance Activities 2016-2021 as described, have been assessed to be moderately negative, regional and long term. The long term impacts

relate to the recovery period of peatland ecosystems. Although many of these are already degraded, the current description and approach to maintenance activities does not allow for degradation of peatlands, currently in good status.

Many catchments with channels or embankments subject to maintenance activity have high proportion of peatland and waterbody land cover (see Table 6-10). For these catchments there is a greater potential for impacts to occur.

Objective B4: Protect, and where possible enhance, hedgerows and woodlands within the riparian corridor.

The conveyance of arterial drainage channels and structural integrity of embankments can be influenced by vegetation growth and so maintenance is undertaken on these. Excessive tree cover can also have negative fisheries impacts. At the same time hedgerows and woodlands in riparian corridors and near embankments can provide multiple benefits including:

- Shading of watercourses, to reduce temperate with subsequent influence of growth and chemistry.
- Habitat for birds, bats and insects.
- Feeding and foraging tracks for mammals such as badger and otter
- Potential Annex I habitats (e.g. alluvial woodland).
- Buffer strips to filter runoff, sediment and nutrients from entering watercourses.
- Natural bank protection.

The description of the Arterial Drainage Maintenance Activities 2016-2021 does not allow for the avoidance or mitigation of moderate negative, long term and regional impacts. The duration relates to the potential recovery period of mature woodland if cleared from a river bank. Many of the impacts arise through the establishment and clearance of maintenance access corridors (MAC) along riverbanks and where access is required to within the river channel. Insert: The footprint of a MAC is usually defined along a drainage channel due to repeated drainage activities over the decades. However, these can become overgrown in the period between maintenance cycles and can form scrub and riparian woodland habitats.

Improvements in the planning process for maintenance activities are ongoing focusing on locations where tree management activities can establish pathways for negative impacts. Such improvements will consider tree management locally and seek to avoid detrimental impacts. The impacts of such improvements have been incorporated into the residual impact assessment.

The OPW are currently beginning to adopt the approach of grass management on flood defence embankments, whereby regular mowing will prevent scrub and woody vegetation from establishing. Where this approach has not been implemented on embankments to date, an ecological assessment will be required to identify any potential impacts by carrying out the works.

There is no facility for the enhancement or creation of hedgerows and woodlands in the Arterial Drainage Maintenance Activities 2016-2021.

Objective B5: Minimise the risk of spread of any invasive aquatic or terrestrial species.

The description of the Arterial Drainage Maintenance Activities 2016-2021 contains details of the mitigation measures to be applied to minimise the spread of invasive species both within the same catchment and to other catchments. There is no protocol or system for formally screening for the presence of invasive species or implementation of control measures to remove, eliminate or minimise the risk of colonisation by invasive species within the maintenance activity documentation. All 34 catchments subject to the Arterial Drainage Maintenance Activities 2016-2021 contain invasive species.

The impact of maintenance activities as described is considered moderate negative with potential long term and regional impacts.

Invasive species control work is highly specialist, however training can raise the awareness for identification of invasive species and to minimise the potential for the spread of invasive following maintenance activities.

10.2.3 Objective C Environmental (Fisheries): Protect and, where possible, enhance the integrity of fisheries within the Arterially Drained catchments.

Sub-Objective C1: Maintain existing habitat supporting salmonid fisheries and carry out enhancement where possible.

Twelve of the thirty catchments subject to the Arterial Drainage Maintenance Activities 2016-2021 contain salmonid designated waters.

The impact of maintenance activities on these watercourses is uncertain at the catchment scale and will be dependent upon several factors such as the extent of in-channel works such as dredging, the distance of the drainage channel from the salmonid waters and the timing of the maintenance activity. The activities can be of detriment over the long term and on a regional scale, however EREP schemes can have local benefits. The catchment wide benefits and impacts of EREP and maintenance activities together has not been studied thoroughly. An assessment on a post-drainage fishing rehabilitation programme of the Boyne catchment was carried out by O'Grady (1990) assessing salmon stock post-drainage and suggests a positive impact, however, there does not appear to be enough scientific evidence in the assessment to determine the impact of drainage maintenance activity. Further studies on the state of fish stock post-maintenance and post-restorative activities (ie: EREP) should be considered.

Sub-Objective C2: Ensure no adverse effects on commercial shellfisheries.

Fifteen of the thirty catchments subject to the Arterial Drainage Maintenance Activities 2016-2021 drain to shellfish waters. Within these catchments where there is a potential connectivity between the maintenance location and the shellfish waters the impacts of maintenance activity have been assessed to be minor negative and long term due to the recovery period of shellfish waters.

10.2.4 Objective D Environmental (Climate Change): Minimise the climate change impacts of Arterial Drainage Maintenance Activities

Sub-Objective D1: Reduce greenhouse gas emissions from machinery and equipment used in Arterial Drainage Maintenance Activity.

The scale of maintenance activity across the country indicates the potential for a notable level of emissions. Machinery use and mileage is logged by the OPW but greenhouse gas emissions and embedded carbon equivalent in materials are not recorded or logged. The Arterial Drainage Maintenance Activities 2016-2021 is likely to be one of the OPWs largest source of greenhouse gas emissions which cumulatively have potentially permanent, international impacts. A baseline needs to be assessed and annual targets to reduce emissions should be embedded into the OPW corporate systems for management, procurement and use of machinery and vehicles. It is recommended that the OPW or their agents undertake a carbon counting exercise as per the ISO 14604: Part 1 standard to calculate the carbon footprint of the maintenance activities. This exercise could be further extended to developing a programme to reduce the current carbon footprint and the project could be verified as per ISO 14604: Part 2. The reduction in the carbon footprint of maintenance activities could be verified and would be proactive by the OPW in reducing their carbon footprint. The recent Climate Action and Low Carbon Development Act 2015, has placed legal obligations on all Government Departments to consider climate change effects and the need for greenhouse gas mitigation measures. The approach recommended above will assist the OPW in achieving their legal requirements.

Sub-Objective D2: Minimise release of sequestered greenhouse gases from sinks such as peatlands and forests.

For catchments where maintenance activity interacts with the hydrology and condition of peatlands and forests there is a moderate negative impact on a catchment scale, which could lead to permanent release of a nationally important carbon store. At present, there is no formal screening process or SOP for specifying or detailing maintenance activity, including access routes, to avoid or mitigate such impacts. The progression of pilot studies recommended in the National Peatlands Strategy have been considered in the residual impact assessment.

JBA recommends a number of approaches to mitigating the release of sequestered carbon. A simple approach would be a tree planting programme that would negate the losses of sequestered carbon. Another approach and one that can be verified is the ISO 14064 route as is

suggested above, a Part 1 ISO 14064 carbon footprint for the maintenance activates. A programme to reduce the carbon footprint would be undertaken. This would result in a reduction in the tonnes of carbon dioxide emissions arising from maintenance activities. These 'saved' tonnes of carbon dioxide emissions would then be offset against the tonnes of sequestered carbon lost during the maintenance activities. This approach would also satisfy the OPW's legal commitments under the Climate Action and Low Carbon Development Act 2015.

The complex system contains multiple feedback loops influenced by natural and anthropogenic variables. The connectedness of the system is displayed in the strong interrelationship between ecosystem functions such biodiversity, water quality, carbon storage capacity, recreation, and flood attenuation. These ecosystem services such as carbon storage can be enhanced with appropriate land use management practices and mitigation measures.

Monitoring will be challenging and extracting the OPW influence (impact or benefit) from other bog-related activities will be very difficult.

10.2.5 Objective D Environmental (Climate Change): Adaptation to climate change.

Sub-Objective D3: Performance of arterial drainage scheme channels, embankments and flood relief schemes over time.

Sub-Objective D4: Adaptive capacity of ongoing maintenance activities to current and potential future demands.

The assessment of the Arterial Drainage Maintenance Activities 2016-2021 on these two sub-objectives is uncertain due to the lack of evidence to form a baseline of future performance of schemes. There is the potential that the current maintenance activities and planning process could be reducing the adaptive capacity of drained channels and embankments. This could have long term, regional implications.

Adaptive Capacity Case Study:
Comparison of Moy Arterial Drainage Scheme and Maine Arterial Drainage Scheme

Climate change prediction	Maine Scheme	Moy Scheme
	Small coastal scheme with embankments and high sensitivity to climate change.	Large catchment with lower sensitivity to climate change.
Increase sea level rise	Coastal embankments will be faced with reducing standards of protection and increased likelihood of failure with rising sea level.	Sea level rise is not likely to impact the current performance level of the scheme; therefore, enhancement of drainage capacity is not foreseen.
Increase rainfall potentially increased fluvial flows and levels.	Potential for reducing standards of protection and increased likelihood of failure with increase fluvial flows and levels.	Enhancement of the drainage is not foreseen, however, schemes should continue to be maintained to an effective condition to avoid deterioration of performance levels.
Change in rainfall patterns	Potential for reducing standards of protection and increased likelihood of failure. Improvement in the understanding of the impacts on land saturation and water-logging will likely inform future adaptation measure. The effectiveness of backdrains and stability of embankments could be compromised.	Future changes in rainfall patterns are likely to be beneficial with regards to the objectives of the Arterial Drainage Scheme based on drainage during drier, warmer months, but could be detrimental in the case of wetter months. Continued repeat winter storms could significantly reduce the drainage capacity of the scheme. Higher levels of soil saturation in peatland uplands may influence the flow regime of scheme channels. Improvement in the understanding of the impacts on land saturation and water-logging will likely inform future adaptation measures.

10.2.6 Objective E Social: Public access and recreation.

Sub-Objective E1: Avoid negative impacts to existing water-based leisure activities.

A number of waterbodies such as the River Moy and the Corrib offer angling of international interest. In these catchments, Arterial Drainage Maintenance Activities 2016-2021 have the potential for detrimental impacts, however the continuing high profile status of these watercourses for angling suggest that maintenance activity is not diminishing the amenity value for angling. In our assessment, we have rated this impact as neutral in most catchments.

Some watercourses are used for canoeing where there may be localised, temporary impacts during the actual works.

Catchments with significant lakes are often used for recreational boating, sailing as well as angling. There are also catchments and embankments which could influence bathing waters and coastal recreation amenity value. In general, the impact of maintenance activity on water-based leisure activities is neutral and only temporary and localised during the actual works.

10.2.7 Objective E Social: Contribute to viable and sustainable local communities.

Sub-Objective E2: Contribution to health and wellbeing of local communities including local employment.

Sub-Objective E3: Maintain access to local services and transport networks up to the design standard of protection.

The Arterial Drainage Maintenance Activities 2016-2021 are assumed to continue to provide the same level of land drainage and flood risk protection as the current maintenance activities (2010-2015). These provide a minor benefit to rural communities and a moderate benefit to maintaining access to local services and transport networks. Maintenance activities contribute to medium term and regional benefits by enabling sustainable rural communities to develop. Ceasing maintenance activities could result in negative impacts on local communities.

10.2.8 Objective F Economic: Avoid damage to, and where possible improve, the function and quality of the soil resource.

Sub-Objective F1: Maintain soil quality and function for productivity on agricultural lands.

Benefitting lands are by their nature subject to increased land drainage and flood protection. The current maintenance activities and proposed Arterial Drainage Maintenance Activities 2016-2021 will continue to provide the same degree of land drainage and flood protection as present.

Continued flood protection is likely to reduce the potential for sediment and nutrient input to soils. Drainage of land has altered the soil structure from natural conditions, improving soil conditions for agricultural use by reducing waterlogging. Ceasing maintenance activity in some cases may return land to a more natural state with the soil no longer being suitable for agricultural activity. The assessment of maintenance activities in terms of their impact on soil resource for agriculture is a neutral impact over the medium term at the regional scale due to the combination of negative from loss of sediment deposition to floodplain and positive from increased drainage allowing productive agriculture. The assessment of this objective is not related to peatland, wetland or soil resource for non-agricultural use.

10.2.9 Objective F Economic: Support agricultural activity without conflicting with environmental objectives.

Sub-Objective F2: Maintain lands available for economic activity and no change as to render existing economic activity unviable.

The original intention of Arterial Drainage Schemes and Land Commission Embankments was to improve the agricultural productivity of poorly drained or land liable to flooding. Continuation of current maintenance activity in the Arterial Drainage Maintenance Activities 2016-2021 will have moderate positive impacts on agricultural economic activity. Confidence in the continuation of maintenance activity will allow for medium term regional economic benefits.

The actual economic benefit that of maintenance activity, in terms of land quality and productivity, has not recently been assessed and is likely to vary regionally.

The Department of Agriculture, Food and the Marine is currently preparing a national strategy for the Agri-Food Sector up to 2025 (Food Wise 2025),which will outline the key actions required to ensure that the agri-food sector (primary agriculture, the food and beverage industry, fisheries

and fish processing, forestry and forestry processing) maximises its contribution to overall economic growth, job creation and environmental sustainability over the coming decade and builds upon the progress achieved under Food Harvest 2020. Arterial Drainage Maintenance Activities (2016-2021) will ensure the objectives function and capacity of the drainage schemes maintain appropriate performance levels to ensure that the objectives are met in terms or agricultural economic activity.

10.2.10 Objective G Cultural Heritage: Protect known features of cultural heritage.

Sub-Objective G1: Protect architectural buildings and structures listed on the Record of Protected Structures (RPS) and designated areas of architectural importance such as Architectural Conservation Areas (ACAs).

Maintenance works should seek to avoid all impacts with known sites and features of archaeological and architectural interest. If avoidance is not possible, full archaeological recording must be carried out in advance of such works and under licence from the DAHRRGA, to preserve the site by record.

Sub-Objective G2: Protect archaeological features listed on the Record of Monuments and Places (RMP) or other listed National Monument and Archaeological Sites.

Systematic cultural heritage assessment and survey of the known and potential remains and their contexts ahead of maintenance works associated with the Arterial Drainage schemes will help to further identify the nature and extent of known archaeological and architectural heritage remains, and may result in moderate positive impacts on the cultural heritage resource. The actual benefit is not known as the assessment to date has been piecemeal based on a case-by-case basis and is not yet national in scope.

At present, there is no SOP for Archaeology and Cultural Heritage within OPW's arterial drainage maintenance activities. Consequently, OPW has no managed approach to the identification and resolution of archaeological and cultural heritage assets within its arterial drainage network, either during pre-works or operational phases. The identification, discovery and resolution of such assets becomes a reactionary response provoked by a requirement of the Development Applications Unit (DAU) for such schemes to include Appropriate Assessment and Impact Assessment. A set of SOPs can be identified to improve OPW's position and provide a managed approach to the archaeological and cultural heritage assets that occur within the arterial drainage network.

10.2.11 Objective G Cultural Heritage: Protect unknown features of cultural heritage.

Sub-Objective G3: Protect undiscovered archaeological features.

Systematic cultural heritage assessment and survey of the river systems ahead of maintenance works associated with the Arterial Drainage schemes will help to further identify the nature and understand the locations within river systems that are most likely to retain undiscovered archaeological remains, and may result in moderate positive impacts on the cultural heritage resource.

The actual benefit is not known as the assessment to date has been piecemeal based on a case-by-case basis and is not yet national in scope.

10.3 Cumulative Impacts/ In-combination effects

10.3.1 With Relevant Plans and Strategies

There is a potential for interactions between the draft Arterial Drainage Maintenance Activities 2016-2021 and other National, Regional and County Plans and policies outlined in Section 5 of this Environmental Report. These potential impacts could result in additional in-combination effects. These plans, programmes and policies include:

Floods Directive and Flood Risk Management Plans

The recently published Flood Risk Management Plans (FRMPs) from the CFRAM programme set out measures for managing flood risk in each CFRAM Unit of Management. The FRMPs consider existing drainage schemes, embankments and flood relief schemes and the ongoing maintenance of these. All FRMPs contain measures to continue to maintain these. The draft Arterial Drainage Maintenance Activities (2016-2021) do not propose to change any of the maintained channels, embankments of flood relief schemes. The periodical maintenance will not have any impact on the delivery of the FRMPs. This SEA has recognised that there are potential impacts of the original Arterial Drainage Schemes and that maintenance activities may be contributing to continued negative impacts of these schemes. The implementation of the recommended mitigation measures in this report will require further assessment to ensure that there are no impacts that result from changes in approach to maintenance activity. The assessment should occur at the design and development stages of the mitigation measures. Revisiting some of the objectives of Arterial Drainage Schemes may allow for catchment wide measures to manage flood risk. Future flood risk and drainage management planning need to be aligned.

The Water Framework Directive

The requirements of the Western River Basin Management Plan have been integrated into the Arterial Drainage Maintenance Activities 2016-2021 through the inclusion of a SEA objective dealing with the Water Framework Directive. The Department of Environment, Communities and Local Government (DECLG) is the lead Government Department for the WFD, and the nominated Competent Authority for establishing the environmental objectives and preparing a programme of measures and the River Basin Management Plans. The OPW has held bi-lateral meetings with senior representatives in DECLG to establish the appropriate methods and approaches to coordination, which were agreed to be primarily through cross-representation on management / governance groups.

For the second cycle of implementation of the WFD, the Environmental Protection Agency (EPA) has been defined as the Competent Authority for undertaking the characterisation and reporting to the Commission, and is also required to assist the DECLG in its assigned duties. The OPW has held bi-lateral meetings with the EPA since 2013 to determine the suitable approaches to the practical aspects of implementation, which were agreed to be through cross-representation on management / governance groups, and ongoing bi-lateral meetings.

The Habitats Directive

The Habitats Directive and its requirements have been considered by the inclusion of a number of SEA objectives dealing with habitats, the protection of Natura 2000 sites and conserving local ecology. The Arterial Drainage Maintenance Activities recognises the need to protect Special Protection Areas and Special Areas of Conservation. A large portion of the country is designated for its biodiversity and it is a requirement to protect and conserve these habitats. Both, the Arterial Drainage Maintenance Activities 2016-2021 and project level work is subject to Appropriate Assessment (AA). Natural Heritage Areas (NHA) were also considered during the assessment of the maintenance activities. The spread of invasive species can threaten native species and it is important that measures to control the spread of invasive species is considered in the Construction Environmental Management Plan for individual maintenance projects.

Ireland's second National Biodiversity Plan was published in 2011 and covers the period to 2016. This Plan was prepared against a background of increasing biodiversity pressures and losses at both European and global level. It contains 102 actions that aim to better understand and protect biodiversity. Some key actions for the agriculture sector and of relevance to the draft Arterial Drainage Maintenance Activities 2016-2021 are as follows:

- develop measures in future rural development programmes for the protection and enhancement of ecosystem services and biodiversity;
- further develop criteria to identify High Nature Value (HNV) farmland and develop measures to address threats to HNV;
- effective implementation of cross-compliance and statutory management requirements to ensure conservation of biodiversity;
- conduct a systematic evaluation process for any agri-environmental schemes delivered, involving a robust ecological monitoring programme.

Increased habitat diversity and connectivity can provide beneficial pollination and natural biological control of pests.

The impacts of drainage maintenance activity will vary by location, catchment and habitats. It is not possible to assess the impacts at this scale, Natural 2000 site and an Appropriate Assessment of catchment and project scale activities is necessary.

Coillte BAU 2 Strategic Plans 2016-2020

Each of Coillte's eight Business Area Units (BAU) contain arterial drainage scheme channels and embankments. The purpose of the BAU strategic plans is to set out plans for the forest and non-forest business that will take place in the BAU during the plan period. Coillte's aim is to develop its forests in a way that is environmentally sustainable, socially sustainable and economically sustainable.

Non-structural measures are one of the methods to help control flood risk in an area. Land use management and in particular the presence of forestry in upland areas can minimise the extent and the duration of floods experienced downstream. The ability of the woodland soils to quickly absorb and store rain water is a well-known fact. Interception of rainfall by their canopies can significantly reduce the amount of rain fall that falls on the ground. They also, by their presence hold back and delay the run-off of rain water to rivers and streams.

The interactions between the forest strategies and drainage maintenance activity will vary by catchment and also at a sub-catchment scale and need to be considered at project level assessments.

County Development Plan and Local Area Plans

The Arterial Drainage Maintenance Activities 2016-2021 do not need to be integrated into County Development and Local Area Plans. Some of the recommended mitigation measures could feed into the environmental, amenity and social objectives of these plans. As land management and natural flood management practice evolves in Ireland, land use plans may need to be updated to account for designation or zoning of land as natural flood management assets.

At a strategic level there will be no additional or cumulative effects on the environment if the maintenance activities proposed are implemented in combination with the proposals contained in the County Development Plan and the Local Area Plans.

Food Harvest 2020 and Food Wise 2025

The evolution of Arterial Drainage Maintenance Activity planning and particularly the Natural Flood Risk Management Measure must be aware of the requirements of Harvest 2020 and Food Wise 2025. The impacts of which are not possible to assess at this scale and will be considered in catchment, scheme or project scale assessments.

INSPIRATION

The EU funded project aims to develop a European Research Roadmap on sustainable land management practices. The project aims to identify lands ability to sustain biodiversity and provide society's needs. The Land Use Management recommended mitigation measures included in this SEA need to fulfil the requirements for this programme.

The 2015 Climate Act

Run off reduction actions are likely to have a positive effect on carbon storage across most ecosystems due to the high carbon content of the soil. The planting of deciduous and conifers trees will also benefit carbon sequestration. Arterial Drainage Schemes and Embankments have the potential to contribute to climate change adaptation. The actual impacts need to be considered in catchment, scheme and project scale assessments.

Ireland's Rural Development Programme 2014-2020

The programme identifies Ireland's green credentials for food production and suggests that this should be maintained through the Harvest 2020 and Food Wise 2025 programmes. While the level of High Nature Value (HNV) lands in Ireland has been noted above, the concept of HNV land is not yet fully established in Ireland and HNV land has not been specifically designated or mapped. There are opportunities between stakeholders to identify the HNV lands and to avoid

these as Natural Flood Risk Management areas. Food Harvest 2020 and Food Wise 2025 may result in intensification on marginal lands in some areas, lands which may benefit Natural Flood Risk Management measures.

10.3.2 With Related Ongoing Activities

Agricultural Land Management Practises and GLAS Schemes

The intention of the GLAS schemes is for environmental measures to be incorporated into agricultural land management practices. One of the benefits of such schemes is the incorporation of buffer strips at field and watercourse margins. These have the potential for cumulative reductions in sediment and runoff discharge to arterial drainage channels, thus reducing the need for maintenance activities. Further studies are required to ascertain the level of benefit that can be delivered from such schemes.

In addition, GLAS schemes provide a source of income to landowners and farmers. This income could potentially offset any reduction in land drainage function should maintenance activity reduce. This would need to be considered at a local scale to ensure that there is no impact on productive agricultural lands.

There is insufficient scientifically robust information to assess the cumulative impact of agricultural activity across a catchment in combination with arterial drainage maintenance activities. Further targeted monitoring and research is required to understand catchment processes. Maintaining to the original scheme design standard should also be included in such research to determine whether periodic maintenance activity should consider alternative design standards. The Department of Agriculture, Food, and the Marine are conducting research on pilot catchments nationally for various agricultural pressures.

Forestry

Different stages of the forestry cycle have different impacts on catchment hydrology and sediment regime. Both arterial drainage maintenance and forestry activities are periodic and at the local and sub-catchment scale could if the timing is not managed, result in greater impacts when considered in combination. An example would be the clear felling of forest land adjacent to an arterial drainage channel, at the same time as clearance of riparian vegetation along a maintenance access corridor and in-channel silt and vegetation works. Should such simultaneous activities occur during or just before heavy rainfall, sources and pathways of potential impacts could be experienced. This highlights the need to catchment management and stakeholder involvement.

Forestry also has the potential to reduce runoff and manage sediment sources reducing the requirement or frequency of certain types of drainage maintenance activity, however, temporal changes or inappropriate forest management practises can result in increased runoff and sediment input. Further research on forestry as a form of natural flood management in Ireland is required before the potential benefits and impacts can be assessed with reasonable certainty.

10.3.3 Cumulative Impacts of Maintenance Activity

Drainage District Maintenance within the Same Catchment

In many catchments there are significant areas of drainage districts and channels or embankments subject to Arterial Drainage Maintenance Activities. One such example is the Galway Bay South East catchment which has a significant area covered by drainage districts maintained by Galway County Council and a very limited extent of OPW maintenance activity. The OPW arterial drainage maintenance activity on their own may have an insignificant impact, however the Galway County Council maintenance could have substantial impacts. In such catchments the OPW should consult and work with other drainage authorities to ensure environmental impacts at the catchment and project scale are managed.

11 Recommended Mitigation Measures

11.1 Introduction

Mitigation measures are recommended where our assessment has identified significant negative impacts on the environment. Based on the source/pathway/receptor concept where an environmental burden (e.g. water pollution, noise etc.) can impact on a receptor e.g. human, water, biodiversity or landscape via particular pathways, these significant impacts can be either mitigated at:

- Source e.g. avoid the impacts at source
- Pathway e.g. reduce the magnitude of the impact
- Receptor e.g. compensate for the impact by providing an alternative

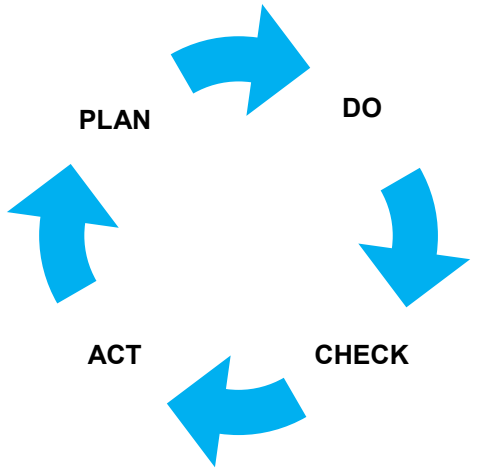
To negate or minimise these impacts, mitigation measures are set out in the following sections. The assessment tables given in Volume IV: Appendix D indicates that in most cases, and in the absence of suitable site specific mitigation measures, maintenance activities will impact negatively on the environment. A number of mitigation measures are recommended at this stage. These mitigation measures have been grouped into seven categories. Not all the recommended mitigation measures are appropriate for all catchments and they are in addition to the current Standard Operating Procedures (SOPs) and Environment Management Protocols. The selection of which mitigation measures apply to which catchments and maintenance works should be undertaken in the 6-year and annual maintenance planning process. The tables in Volume IV: Appendix D show how the implementation of the recommended mitigation measures have the potential to significantly improve environmental and social performance of maintenance works. Notable improvements can still be realised through implementing some of the recommended mitigation measures but this has not been assessed for any catchment at this stage.

All recommended mitigation measures can be achieved in practical terms. Budget and organisation frameworks may present constraints to implementing some of the recommendations in the short term.

11.2 Environmental Management System

JBA's review of the SOP's and our understanding of the Maintenance Activities identified the benefits to the OPW of a simple environmental management system (EMS). While the EMS would not be certified to the ISO 14001 standard some of the overarching principles of the standard would be applicable and beneficial to the Maintenance Activities. An active EMS illustrates the concepts of continual improvement to Statutory Bodies and other interested stakeholders. It is proposed that the simple EMS would follow the basic principle of the ISO 14001 standard as illustrated in Figure 11-1.

Figure 11-1: Plan-Do-Act-Check principle of ISO 140001 standard



In the following sections of this Environmental Report we have listed several procedures that will assist in achieving sustainable arterial maintenance activities. Using the principle of continuous improvement, JBA has identified a number of procedures that will be required to achieve this goal. JBA considers that the development of new or revised procedures is outside the scope of the SEA and is better left to the OPW, however JBA have listed procedures that will be required. Many of these procedures will require a revision to the current SOPs or the development of new SOPs. The SOPs should be controlled documents with the responsibility of one person to create, manage and update the procedures when necessary.

JBA recommends annual audits of the in-house EMS to help identify areas or procedures that need amending. It is recommended that the simple Plan-Do-Check-Act principle should be incorporated into all the maintenance activities. A simple pre-maintenance activity assessment of a site should be undertaken and recorded. Environmental constraints (e.g. SAC or protected species) would be identified at this stage and the relevant environmental measures put in place. The maintenance operatives would be advised of the correct procedures prior to commencing the work. A number of checks would be carried out and recorded during the works.

A post maintenance assessment would be carried out to assess the effectiveness of the procedures and the requirement to amend the procedures for future works. The findings of this assessment would be recorded.

The pre and post maintenance records for the different schemes would be reviewed on an annual basis by management with the sole purpose of learning from the previous year's experiences and amending SOPs where necessary.

11.2.1 M1 - Improved Maintenance Planning (6-year and annual plans)

These recommended mitigation measures are concerned with continuously improving the types of maintenance activity and the way in which these are specified for specific channels, embankments and structures. They also include recommendations for enhancing the consultation on the 6-year and annual maintenance programmes, sharing of information with stakeholders and incorporating third party information into the planning and decision making process. There are many research projects, best practise examples, methods and guidance reports that can be applied to the planning of OPW maintenance activity in Ireland.

The recommendations should apply to maintenance of all drainage scheme channels, embankments and structures which the OPW has responsibility for. The processes developed should be shared with Local Authorities and other bodies responsible for flood risk, drainage and coastal protection asset management as national best practise and continuously improved as new information is available or processes develop.

Table 11-1: Improved Maintenance Planning Mitigation Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M1a	Incorporate GIS data from other bodies in maintenance activity decision making GIS systems	Examples include: - National Road Network to ensure consideration of health & safety, and identify potential impacts on standard of national road network. - National Monuments Service SMR and NIAH database. - Protected and sensitive species and habitat data. - Consideration of WFD status, hydromorphological pressure or protected structures when specifying maintenance activities. (e.g. RHAT or MQI datasets) - Presence of Invasive Species -WFD status and RBMP objectives.	Short-Term

M1b	To maintain, update and share GIS information on arterial drainage scheme channels, embankments and structures. Maintenance programmes to be made available, if possible in GIS format, but as a minimum with reference to GIS information.	To enable other bodies and stakeholders to view maintenance programmes and understand maintenance responsibilities. To make it easy for others to understand the planning process. More informed consultation responses from stakeholders. An example is the publication of Environment Agency main river maintenance programmes for England[8].	Short-term
M1c	Specific and targeted consultation of the 6-year and annual plans with stakeholders for high risk or sensitive impacts, activities or locations.	With a GIS system in place which contains attributes of sensitivities for channels based on current datasets it should be straightforward to select channels to refer to relevant stakeholders for specific advice when selecting maintenance activities in the most critical locations. The OPW are committed to create a barrier layer utilising fisheries source data. Examples include: - OPW, EPA, ESB (& other) hydrometric teams where any activity which could influence water levels or flow rates is proposed such as barriers in channels from weirs. Through the existing Hydrometric Working Group. - With Transport Infrastructure Ireland in the proximity of national roads. With NPWS (via DAU) for habitats directive and archaeologically sensitive locations.	Short-Term to Long-Term (ongoing)
M1d	Cross-border consultation with relevant Northern Ireland bodies on 6-year and annual maintenance programmes.	Only relevant to maintenance programmes for catchments which overlap the boundary with Northern Ireland.	Short-Term to Long-Term (ongoing)
M1e	Planning for Appropriate Assessment project level AA Screening, consultation and license application routes for Wildlife Act and Habitats Directive.	This is to ensure timely development of detailed plans of works where Appropriate Assessment Screening, notifications or license applications will be likely. This will ensure that necessary surveys can be commissioned and completed in the correct season and allow works to progress, where appropriate, during the applicable timeframe. The correct timing of surveys is critical to the quality of the Appropriate Assessments and application for derogation licenses. Licensing from DAHRRGA for archaeological aspects.	Short-Term
M1f	Refine the suite of maintenance activity types and methods.	This is to allow for a broader suite of possible maintenance activities for selection, so potential impacts can be avoided or mitigated at the planning stage, by selecting the most appropriate environmentally sensitive maintenance method for specific local conditions.	Short-Term to Long-Term (ongoing)

8 https://www.gov.uk/government/publications/river-and-coastal-maintenance-programme

		At the planning stage, consideration for alternative approaches should be considered such as natural flood management and land management practices and the environmental conditions. Details of the recovery and response of the channel form and vegetation to maintenance activity types and methods should be used to inform the frequency of maintenance and duration of likely impacts. Examples include: - ADA & Natural England Drainage Channel Biodiversity Manual[9] - Environment Agency and Defra Channel Management Handbook (SC110002/)[10] - Environment Agency and Defra Aquatic and riparian plant management: controls for vegetation in watercourses (SC120008)[11] - Thames Estuary Partnership and Environment Agency. Estuary Edges: Ecological Design Advice[12] - IFI Guidelines for the protection of fisheries during construction works in and adjacent to waters[13]	
M1g	Improved planning of maintenance activity, based on international best practice and tools to: a) incorporate hydromorphological assessment of channel type and conditions. b) screen for archaeological and cultural heritage impacts. c) minimise the spread and colonisation of invasive species. d) minimise impacts on and enhance conditions for sensitive species and habitats. e) minimise impacts upon and enhance wetland and	This is to select, from the refined maintenance activities, what to specify for different catchment, channel and structure types. JBA recommends an environmental assessment of the most sensitive locations of the planned works before they commence. This would involve a site walkover with an ecologist and an archaeologist to identify any potential constraints for the planned arterial drainage maintenance works including access to the location of planned works. The objective of this mitigation measure is for the 6-year and annual maintenance programmes to avoid impacts, or where not possible, mitigate for impacts. The OPW is committed to developing and introducing a precautionary environmental risk assessment (ERA) inorder to identify in a preliminary way areas of potential risk or ecological/environmental sensitivity. Pilot studies will be implemented and findings will inform future maintenance planning.	Short-Term to Long-Term (ongoing)

9 Buisson, R. S. K., Wade, P. M., Cathcart, R. L., Hemmings, S. M., Manning, C. J. & Mayer, L. (2008). The Drainage Channel Biodiversity Manual: Integrating Wildlife and Flood Risk Management. Association of Drainage Authorities and Natural England, Peterborough.

10 https://www.gov.uk/government/publications/channel-management-handbook-for-flood-risk-management

11https://www.gov.uk/government/publications/aquatic-and-riparian-plant-management-controls-for-vegetation-in-watercourses

12 http://www.ecrr.org/LinkClick.aspx?fileticket=toZTNTJ5zXA%3d&tabid=2624

13 http://www.fisheriesireland.ie/fisheries-management-1/624-guidelines-on-protection-of-fisheries-during-construction-works-in-and-adjacent-to-waters

	peatland ecosystems. f) consider aquifer type and status.	JBA recommends the appointment of an experienced and qualified underwater archaeologist as project archaeologist to advise OPW and to manage the archaeological risk of the drainage programmes. The project archaeologist will be part of the OPW's design team for arterial drainage programmes, with responsibility for managing the archaeological risk with a view to reducing the level of archaeological risk. The project archaeologist will liaise with the National Monuments Service (NMS), to agree the consents and scopes of work required on drainage programmes. Use of EPA fluvial geomorphological assessment based on MQI tool (in development), River Hydromorphology Assessment (RHAT)[14] and other river restoration tools and guidelines (e.g. REFORM and River Restoration Centre). Screening of aquifer type to rule out where certain activities should not be undertaken. For example, karstic groundwater bodies can have high levels of connectivity between maintenance locations and sensitive wetland annexed priority habitats such as Turloughs. Further investigation could inform future studies, if unproductive aquifers and impermeable soils have potential for greater surface runoff or quick flow and so potential for direct links between maintenance locations and sensitive habitats and species.	
M1h	Consider CSO and other significant surface water discharges to arterial drainage schemes. Consult Irish Water and National Federation of Group Water Schemes on 6-year and annual maintenance programmes	The impact of changes in flow or level from maintenance activity on discharges and downstream quality should be considered. In nitrate sensitive areas diffuse pollution should also be considered.	Long-Term
M1i	Ongoing training and continuous staff development of management and engineers involved in planning and specifying maintenance activities.	Continuous staff development will be required to maintain skills and understanding as research evolves.	Short-term and Long-term (ongoing)

11.2.2 M2 - Improved Standard Operating Procedures and Environmental Protocols

These recommended mitigation measures are focused on addressing concerns from key stakeholders on the methods and approach to undertaking specified maintenance activities. The intention of these recommendations is to further facilitate good environmental practices in the field. They focus on how maintenance activity is carried out once it has been specified for channels, embankments and flood relief schemes in the 6-year and annual programmes. These should be considered as continual improvement of existing procedures as opposed to new extra standards and guidelines to be followed.

Table 11-2: Improved Standard Operating Procedures and Environmental Protocols Mitigation

14 https://www.daera-ni.gov.uk/sites/default/files/publications/doe/water-guidance-river-hydromorphology-assessment-technique-training-manual-version-2-2014.pdf

Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M2a	Where appropriate, update SOPs to include methods and techniques for any works which require transversing, crossing or are in proximity to highways. Updated SOP to ensure designers consult DMRB Road Safety Audit (HD19) to determine whether a Road Safety Audit is required. SoP to ensure responsibilities of designers and operatives are clear and able to be implemented.	Ensure update of SOPs in reference to highway protocols relevant to arterial drainage maintenance activities.	Short-Term
M2b	Update SoPs, EcIAs and Environmental Protocols to continuously improve and facilitate the undertaking of environmentally sensitive maintenance activity as specified out in 6-year and annual maintenance programmes.	Specific improvements required at present to comply with environmental sensitivities include: - Standards for design drawings and instructions, including detailed description of works and mitigation measures for appropriate assessments - Timing of surveys for appropriate assessments and license applications - Incorporation of current best practise and guidance into species specific EcIAs - Consider findings of the Forestry and Freshwater Pearl Mussel Requirements - New EcIAs for species and habitats not currently covered (e.g. riparian woodland, wetlands and peatlands) - Inclusion of when and how to consider ecological constraints of specified activities, - Invasive species controls and methods, - Maintenance and establishment of machine access corridors, - Inclusion of refined descriptions and approaches to maintenance activity types and methods (see recommended mitigation measure M1f). JBA recommends an environmental assessment of the most sensitive locations of the planned works before they commence. The OPW is committed to developing and introducing a precautionary environmental risk assessment (ERA) inorder to identify in a preliminary way areas of potential risk or ecological/environmental sensitivity. Pilot studies will be implemented and findings will inform future maintenance planning.	Short-Term and Long-Term (ongoing)
M2c	Develop clear guidance		Short-

	and processes for identifying and protecting cultural heritage and archaeology features.	Ensure that areas adjacent to the works are not of cultural, architectural, or archaeological significance. If so, appropriate measure and guidelines to be used in order to protect these. Such measures may include desk-based assessments and licensed (by DAHRRGA) on-site walkover and/or waded/underwater assessments and survey work to define further the nature and extent of the cultural heritage assets. New guidance to incorporate into updated SOPs and protocols to enable field operatives and engineers to protect known and likely unknown features. The SOPs for Archaeology and Cultural Heritage can be divided into two distinct levels: managerial and resolution. Managerial SOPs for Archaeology and Cultural Heritage include: 1.Appoint an experienced and qualified underwater archaeologist as project archaeologist to advise OPW and to manage the archaeological risk of the drainage programmes. . The OPW is committed to fund a National Study assessing the scale of archaeology and cultural heritage overlap along Arterial Drainage Schemes and determined the potential archaeological impacts caused by maintenance activities. The finding from the assessments will inform pilot studies and/or longer term programme and will determine if further assessment will be required. SOPs for archaeological and cultural heritage assessment and resolution during an arterial drainage works programme should include: 1.The archaeologist will carry out desk-based research as part of the pre-works programme to record the known archaeological and cultural heritage assets within the drainage network. Desk-based work would include examination of the Sites and Monuments Record, the National Inventory of Architectural Heritage, the Historic Shipwreck Inventory; the Topographical Files of the National Museum of Ireland and the Excavations database. Desk-based work would also examine existing and historic cartographic information, landscape drawings and historic photographic sources, and place-name evidence, along with national and local published sources to gain robust insight to the history and development of activity along the river network where possible. 2.The archaeologist will carry out walkover inspection of the river network as part of the pre-works programme, to add a further level of baseline knowledge. Such work will record the	Term

		location and extent of existing archaeological and cultural heritage features in relation to the proposed works programme, and will add new features to that record where evident. 3.From these assessments, pilot sites will be selected and the results will inform longer term programmes and will determine if further assessment will be necessary. A walkover inspection can be complemented with waded and/or underwater inspection by the archaeologist. Such work is licensed by the NMS. 4.The results of the above work will be collated into a project report that presents a narrative of development along the river network, includes an impact assessment that considers the impacts of the drainage works on known sites and areas of archaeological and cultural heritage potential, and includes a set of recommendations that are aimed at managing the archaeological and cultural heritage risk within the constraints of the drainage project, and with a view to reducing the level of archaeological risk. 5.The archaeologist will maintain an active role throughout the works phase, to resolve archaeological and cultural heritage risks during the works phase. 6.A suitably qualified and experienced riverine and/or underwater archaeologist will be appointed during the works phase and tasked with resolving the archaeological and cultural heritage risks identified, and monitoring the works progress to record and resolve any new discoveries that might be made during the works programme.	
M2d	Ongoing training and continuous staff development of field operatives, foremen and local engineers involved in undertaking maintenance activities.	Continuous staff development will be required to maintain skills and understanding as research and methods evolve.	Short-Term to Long-Term
M2e	Check and review SOPs	JBA recommends that an annual review of post-maintenance activities. These reports are to be reviewed annually and where the requirement for additional mitigation measures or a requirement for updated SOPs are identified, these are put in place. JBA recommends that the OPW or their agents conducts an annual review of the SOPs, in-house procedures with a view to updating them.	Short-Term to Long-Term

11.2.3 M3 - Monitoring of all maintenance activity, with continuous improvement through feedback into methods and approach

These recommended mitigation measures address deficits in the range of robust scientific evidence of the potential impacts of maintenance activity. Further monitoring is required to develop evidence in relation to the direct impacts of a maintenance activity, the cumulative impacts of maintenance on multiple drainage schemes within or beyond a catchment, the in-combination effects of maintenance with other land uses and activities. It is also important to

develop scientifically robust evidence on the recovery periods following different maintenance activities and the performance of mitigation measures employed. The findings of the recommended monitoring should feed into continuous improvement of the maintenance activity descriptions, development of maintenance programmes and standard operating procedures.

It is recommended that monitoring is based on a representative sample of all maintenance activity by the OPW and not limited to EREP schemes. If appropriate, and it would add scientific value to the evidence base, other bodies who undertake watercourse or embankment maintenance could contribute.

Table 11-3: Monitoring of Maintenance Activity Mitigation Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M3a	Monitoring of the effectiveness of invasive species control measures	Monitoring to understand the effectiveness of control measures applied to manage invasive species. The monitoring can be used to refine control measures. A pilot study will likely be undertaken before rolling out into current practice.	Short-Term to Long-Term (Ongoing)
M3b	Specific monitoring to build scientific evidence base of impact of different maintenance activities on specific species and habitats of interest to include: - Freshwater Pearl Mussel, - Salmon, - Lamprey, - Crayfish, - Otter, - Badger & other Mammals, - Kingfisher, - and others as appropriate.	This monitoring is to cover a representative sample of maintenance activity, not just EREP schemes. The objective is to build up a knowledge base to inform planning and provide robust scientific evidence for Appropriate Assessments. The knowledge base could be used to inform other bodies such as IFI	Short-Term to Long-Term (Ongoing)
M3c	Specific monitoring of pathways to build scientific evidence base. Research into groundwater pathways to groundwater dependent habitats and species as a priority.	This monitoring is to cover a representative sample of maintenance activity where groundwater pathways may exist, not just EREP schemes. A pilot study would likely be undertaken prior to rolling out into current practice. The objective is to build up a knowledge base to inform planning and provide robust scientific evidence for Appropriate Assessments.	Short-Term to Long-Term (Ongoing)
M3d	Specific monitoring to build scientific evidence base of impact of different maintenance activities on hydromorphology and WFD Status.	This monitoring is to cover a representative sample of maintenance activity, not just EREP schemes. The objective is to build up a knowledge base to inform maintenance planning and compliance with WFD objectives and provide robust scientific evidence for Appropriate Assessments (REFORM tools and guidelines may provide a useful resource). The River Hydromorphology Assessment Technique (RHAT) is used for WFD classification and it is also used to monitor river rehabilitation sites (EREP). RHAT has become a useful tool for assessing the physical habitat condition by assessing most of the WFD hydromorphological elements, excluding processes, which limits its ability to identify pressures, responses to pressures, and appropriate measures. For that reason, various	Short-Term to Long-Term (Ongoing)

Code	Mitigation Measure	Details and Example Applications	Timescale
		hydromorphological characterisation approaches are being explored including Morphological Quality Index (MQI) assessment tool, which is being modified to adapt to Irish needs. All findings can be used to inform the hydromorphological impact of maintenance activities in a less subjective manner. Continue monitoring in pilot test sites should cover water quality, siltation, hydrology, flow rates, scouring and bank erosion. The extent and duration of impacts following maintenance activity should be covered.	
M3e	Specific monitoring to build scientific evidence on the in-combination and cumulative effects of maintenance activity	This monitoring is to cover a representative sample of maintenance activity and catchment land uses, not just EREP schemes. The objective is to provide robust scientific evidence for appropriate assessments. The monitoring should cover: - recovery after types of maintenance, - evidence that mitigation is effective for specific species/habitat, - in-combination effects of maintenance together with land management practices,	Short-Term to Long-Term (Ongoing)
M3f	Specific monitoring to build scientific evidence base of impact of different maintenance activities on wetland and peatland ecosystems	This monitoring is to cover a representative sample of maintenance activity and wetland/peatland ecosystems, not just EREP schemes. The objective is to provide robust scientific evidence for appropriate assessments and inform maintenance activity planning. The monitoring should cover: - recovery after types of maintenance, - impact of maintenance on wetland and peatland hydrology and ecosystems, - maintenance to scheme design is not causing detrimental impacts (e.g. original scheme design may be detrimental to wetland/peatland habitats and continuing maintenance to this standard despite not introducing new impacts may still be detrimental). A pilot study would likely be introduced prior to roll out into practice.	Short-Term to Long-Term (Ongoing)
M3g	Specific monitoring to build scientific evidence on the effectiveness of mitigation measures	This monitoring is to cover a representative sample of maintenance activity and mitigation measure application, not just EREP schemes. The objective is to provide robust scientific evidence for appropriate assessments and inform continuous improvements in the mitigation measures. The monitoring should cover: - recovery after types of maintenance, - evidence that mitigation is effective for specific species/habitat,	Short-Term to Long-Term (Ongoing)
M3h	Specific monitoring to build scientific evidence	Sites selected for monitoring would be on the basis of having completed a comprehensive	Short-Term to Long-

Code	Mitigation Measure	Details and Example Applications	Timescale
	base of erosion/deposition/ stabilisation factors at known cultural heritage sites and area of potential.	archaeological assessment and impact statement of the proposed drainage maintenance programme and its impacts on known or potential archaeological heritage. The monitoring would cover a representative sample of maintenance activity, to build up a knowledge base to inform maintenance planning and compliance with NMS requirements, and provide robust scientific evidence for AA. Information from the pilot studies will inform potential monitoring. identifying possible sites that include standing remains, earthwork sites and submerged/buried sites/wreck sites, and should include waterlogged areas adjacent to drainage channel that may become dried out as a result of the works.	Term (Ongoing)

11.2.4 M4 - Expansion of river restoration and environmental enhancement

These recommended mitigation measures intend to maximise the benefit of proposed river restoration and environmental enhancement works currently carried out as part of the maintenance programmes under the Environmental River Enhancement Programme (EREP) projects.

The current scope of the EREP works are principally focused on fisheries and WFD criteria and by expanding the scope of the criteria can allow for more opportunities to restore river, coastal, estuarine and wetland environments. Links to the EU Floods Directive and WFD themes of natural flood management and working with natural processes should be explored as part of these recommendations. The REFORM programme deliverables include many tools and guidelines for identifying, planning, designing and implementing river restoration.

Table 11-4: River Restoration and Environmental Enhancement Mitigation Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M4a	Expand the criteria for river restoration and enhancement of EREP works to include opportunities with other benefits, not just fisheries or salmonid potential.	There is an opportunity to broaden the scope of EREP projects to cover all environmental enhancements whilst not compromising land drainage or flood protection. In some cases, restoration could enhance land drainage and/or flood protection. The scope should also cover embankments and older flood relief schemes which may not be performing to their full potential.	Long-Term
M4b	Identify strategic corridors and locations for protection of riparian and floodplain hedgerows and woodlands.	The walkover habitats surveys undertaken to feed into the Natura Impact Statements for each Arterial Drainage Scheme have mapped linear and area woodland and hedgerows to Fossitt habitat classifications. GIS analysis of these datasets, REFORM, MQI and RHAT information can be used to determine a strategic approach to woodland and hedgerow management and enhancement to cover: - identify locations of high value and protected woodland (e.g. alluvial woodland Annex I habitat). - identify woodland that could be critical to the habitat conditions of sensitive species (e.g. woodland near to Freshwater Pearl Mussel locations). - identify gaps or areas with little tree or hedgerow cover as opportunities for creation or	Long-Term

Code	Mitigation Measure	Details and Example Applications	Timescale
		enhancement of such habitat. Specific focus on where buffer strips would be beneficial. - identify floodplain treelines and hedgerows which could manage flood risk and should be considered for protection as natural flood management assets. These could form a GIS screening layers to inform the approach to maintenance activities.	

11.2.5 M5 - Asset Management and Climate Adaptation Planning

These recommended mitigation measures relate to the development of an asset management system approach to maintenance of arterial drainage schemes, land commission embankments and flood relief schemes.

The objective is to optimise the benefit (in terms of economic, social, cultural and environmental factors) delivered from, and to justify, Government expenditure.

An inspection process can be used to refine the maintenance programme, with specific focus on the inspection of structures which would result in significant consequences if they were to fail (e.g. flood relief schemes, coastal embankments).

The future performance of schemes and individual structures should be addressed under a range of future climate change scenarios. This will inform longer term planning as to whether maintenance activities are

a. restricting adaptive capacity,
b. maximising adaptive capacity, or
c. redundant as the scheme in the current form will not perform under climate change scenarios.

This information can be used as evidence to inform future plans for schemes (e.g. enhance performance, walk-away or maintain existing features but at a lower performance standard). Information from the CFRAM process should be used, and where extra information is necessary, inclusion within the specification for 2nd cycle of the CFRAM should be considered.

An asset management approach will become more critical as more flood relief schemes are progressed following the publication and adoption of the CFRAM Flood Risk Management Plans. The extent of maintenance responsibility will grow with the completion of every Arterial Drainage Act flood relief scheme.

Table 11-5: Asset Management and Climate Adaptation Mitigation Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M5a	Incorporate condition inspection into the planning of maintenance activity.	This will enable early identification of assets at risk of failure, especially for flood relief schemes and coastal embankments where the consequences of asset failure are more significant. This will have environmental benefits by enabling less intrusive, more frequent maintenance activity to reduce the need for major refurbishment or replacement which can have greater impacts. An example is the early identification of mammal burrows and implementation of management controls before they cause significant detriment to the condition of embankments.	Short-Term
M5b	Implement an asset management approach	The objective is to optimise available resources as the number of flood relief schemes for	Long-Term

Code	Mitigation Measure	Details and Example Applications	Timescale
	to maintenance of channels, embankments and structures.	maintenance increases. In some cases, the frequency of maintenance can be reduced to match condition and risk. Target condition and performance standards can be monitoring and managed through an asset management approach. It will also allow for structured data management of scheme and structure design and as-built details.	
M5c	Continuous improvement in the environmental performance of machinery and fleet, and materials used.	To reduce carbon emissions and also consider materials used in maintenance activities to reduce the life-cycle impacts of maintenance activity and EREP works.	Long-Term

11.2.6 M6 - Monitoring of environmental conditions

These recommended mitigation measures relate to environmental monitoring and continued review of international science and best practice. The purpose is so that environmental change and land use change can be detected and adjustments made to maintenance activities and plans in advance of problems. The monitoring is of use in justifying public expenditure and identifying early warning signs to trigger changes in drainage maintenance approaches or methods.

Table 11-6: Environmental Monitoring Mitigation Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M6a	Modelling and monitoring of the benefits of maintenance activity	This monitoring would cover hydrology, hydraulic, flood risk and agricultural productivity indicators. The findings would feed into the maintenance planning process and optimise expenditure, whilst complying with the Arterial Drainage Acts and avoiding compensation to landowners.	Long-Term
M6b	Regular review of recent scientific research in climate change, catchment management and continuous improvement of procedures.	Scientific research is continuing to evolve and the OPW should frequently undertake a review of scientific and engineering developments relevant to the maintenance of land drainage and flood relief schemes.	Long-Term
M6c	Link to CFRAM monitoring	The monitoring of environmental change and flood risk should be linked to CFRAM monitoring recommendations for Flood Risk Management Plans in the Units of Management.	Long-Term
M6d	Design survey specification and monitor catchment change (hydrology, hydromorphology and ecology)	The monitoring of key catchment indicators over time at a regional and local scale should be used to highlight key issues which maintenance activity could be influencing. Indicators of catchment change will include hydrology, ecology, hydromorphology (e.g. REFORM, MQI and RHAT), land use cover and land use management. The monitoring should be in conjunction with EPA and NPWS environmental monitoring.	Long-Term

11.2.7 M7 - Natural Flood Management, Working with Natural Processes and Land Management Practices

These recommended mitigation measures relate to the natural flood management and working with natural processes themes in the EU Floods Directive and Water Framework Directive. They

also cover the alignment of maintenance activities with land use planning at the catchment and local scales.

Table 11-7: Natural Flood Management, Working with Natural Processes and Land Management Mitigation Measures

Code	Mitigation Measure	Details and Example Applications	Timescale
M7a	Align maintenance planning with catchment management planning	WFD River Basin Management Plans, CFRAM Flood Risk Management Plans and maintenance activities and plans to complement each other.	Long-Term
M7b	Refine maintenance activity in light of CFRAM hydraulic modelling and Flood Risk Management Plan measures	Use CFRAM findings to refine the maintenance programmes where relevant. Also consider Natural Flood Management recommendations in the Flood Risk Management Plans.	Long-Term
M7c	Identify opportunities and constraints for where maintenance activity can contribute to natural flood management and working with natural processes.	This could be in the form of a catchment scale screening approach (e.g. SEPA and REFORM tools) in conjunction with policy developments to create delivery mechanisms to achieve natural flood management where beneficial.	Long-Term

11.3 Mitigation and Recommendations in relation to Natura 2000 sites

The following is taken from the Natura Impact Report in Volume III. This assessment offers the OPW potential to review and improve upon their current work programme and activities, but also to further investigate areas that may also improve and enhance species and habitat diversity within and adjacent to Natura 2000 sites.

Given the geographical scope of this assessment and the generic description of work activities at this scale, it is not possible to identify specific potential impacts on Natura 2000 sites and their qualifying interests.

The following measures should be incorporated into the overall approach to the Programme of activities. These can be applied to every cycle thereafter and updated or improved when necessary. These are based upon JBA's experience working on projects over recent years and take into account previous comments from NPWS. As the OPW have relied on SOPs and the Environment Management Research projects to date, these have been very helpful in mitigating potential impacts, however these require updating. The OPW should consider the following measures regarding their proposed arterial drainage maintenance programme:

1. The OPW SOPs require updating in relation to details of working methods and mitigation measures detailed therein. This may be done through the revision of the SOPs, or the provision of method statements to supplement the SOPs. Mitigation measures should be site specific and should not only rely on the contribution of bodies such as Inland Fisheries Ireland and National Parks and Wildlife Service. This will provide the OPW with the opportunity to improve the demonstration of their responsibility and compliance under the Birds and Habitats Directive through establishing more detailed working procedures. For example, the current SOP for otter details the avoidance of areas of dense scrub and undergrowth. However, the feasibility of this in practice may not be achievable as it is often areas of overgrowth that need to be removed through the maintenance of areas such as the machine access corridor or those causing obstruction to water flow.
2. The updating of the OPW SOPs should consider the inclusion of the assessment of the potential impacts (not identified in SOPs) that working methods within the riverine corridor may have on adjacent watercourses in relation to the release of suspended solids through activities such as tree cutting, tree removal, bush cutting and the maintenance of MACs.
3. The OPW should include a detailed and quality controlled method statement within an updated SOPs for the management of invasive species. If avoidance of areas containing invasive species is not possible, specific biosecurity and mitigation measures

are required to be in place for the removal, treatment and management of invasive species, when they are encountered on embankments, along river banks or within drainage channels. A protocol for the disinfection, appropriate cleaning of equipment and the disposal of disinfectants should be implemented. JBA have noted that some of the OPW protocols for invasives species are either absent or outdated in SOPs.

4. As the mitigation measures of Appropriate Assessment reports currently rely heavily on the OPW's SOPs, which are supplemented with additional mitigation measures where required, these assessments will need to be revised when an updated version of the SOPs are made available.
5. Overall the update of SOPs requires experienced technical scientists and suitably qualified ecologists to provide input for the updates and consultation with IFI and NPWS.
6. The SOPs should undergo monitoring to examine the success of their implementation. This could be done over a number of years at particularly sensitive sites such as Natura 2000 sites.
7. The Source-Pathway (Ryan-Hanley, 2014a) and Screening Methodology (Ryan-Hanley, 2014b) methods should be updated also. Some examples include: impacts from the embankment activities and tree and bush cutting activities as indirect sources of suspended solids via surface water pathways. Bush cutting, which involves the maintenance of the MAC, should also be included as an indirect source of sediments and nutrients to an adjacent waterbody and a threat to the spread of invasives. The update will look at all potential impacts posed to Natura 2000 sites to ensure they are addressed, thereby ensuring a comprehensive identification and evaluation of potential impacts during the Appropriate Assessment process.
8. OPW currently carry out an Environmental River Enhancement Programme in conjunction with Inland Fisheries Ireland (IFI). IFI monitor the physical habitat and biological elements pre and post works in order to assess the effectiveness of such works on the river corridor biodiversity and hydromorphology. The findings of this monitoring regarding elements such as the recovery time of biotic elements such as instream vegetation, crayfish and lamprey, and river corridor biodiversity. Actions to be taken as a result of the outcomes of monitoring should be identified and the actions undertaken.
9. OPW monitoring programmes are useful in assessing the success of enhancement programmes and restoration projects. Monitoring should be seen as an iterative process with updates or changes where necessary. The monitoring should include for any relevant condition assessments to ensure the special features of a Natura 2000 site and/or protected species are conserved in the best possible condition. Monitoring and evaluation are important in any enhancement and restoration project, as the information gained may lead to greater overall success and reduced costs in future restorations (Sears et al., 2006).
10. The OPW should introduce enhancement programmes for other habitats and species, additional to those for salmonids in river channels. These should also be applied on a catchment wide basis, rather than at specific points along a maintenance channel, which would take the conservation objective for a Natura 2000 site's qualifying interest and WFD objectives into consideration as a whole. Examples include Kingfisher embankments, grey wagtail nests, sandmartin embankments, artificial otter holts etc. It is important that these are designed and suitable areas chosen by suitable qualified ecologists.
11. As discussed in above the commissioning of scientific based pilot studies by the OPW is a great opportunity to improve work practices. A case study (pilot study) approach can be taken where results can be sensibly extrapolated to similar sites. However, in order to assist with pilot studies that can provide greater information and can be applied to a wide number of projects, it is recommended that the pilot studies are chosen based upon a screening process for suitability, applicability to other cases as well as financial for reasons.
12. The OPW can improve the evidence for the effectiveness of river restoration by investing in long-term monitoring (i.e. >5 years) at selected sites. These should encompass a large geographical range and use robust scientific approaches to evaluate projects that

focus on process-based approaches. Monitoring should be undertaken before restoration and afterwards for a sufficient timescale to detect both rapid and longer term changes (Addy et al., 2016).

13. A review of arterial drainage schemes and their interaction with flood relief schemes should be undertaken. It should be discerned what responsibilities and activities are required to be carried out by the OPW as part of channel maintenance within a flood relief scheme so a specific final project design can be assessed through the Appropriate Assessment process.
14. A review of the adaptive capacity of the OPW's flood risk management strategies and measures in relation to climate change should be undertaken as maintaining arterial drainage schemes including those that form part of the Flood Relief Schemes, have the potential to impact on Natura 2000 sites due to their part in flood relief schemes. The impact of maintaining arterial drainage schemes, channels and embankments on the adaptive capacity of ecosystems (including Natura 2000 sites, habitats and species) should also be considered, and fed into the long-term planning for arterial drainage schemes and their maintenance. This may include reconsidering activities in certain areas and examining how restoring ecosystems can play a big role in reducing the risk of the kind of floods.
15. There are opportunities for the OPW to incorporate objectives of the National Biodiversity Plan to minimise biodiversity loss and degradation of ecosystem services, and to optimise biodiversity gains, in flood risk management plans that will be implemented through CFRAMS. This objective should be implemented at project level at both the local and catchment level. For example, green revetement and other novel methods for stabilising bare banks (Koo & Hyojin, 2013). This however, requires training and should not be attempted by OPW staff without appropriate training and certifications.
16. There is a need to further investigate potential and inherent conflicts between flood risk management policy and legislation, and the OPW's statutory arterial drainage programme regarding wetland habitats. European best practise states that enhancing and protecting water retention capacity within catchments (including soil and wetlands) is important at all landscape scales (Williams et al., 2012) and the controlled flooding of certain stretches of riparian floodplains, or creation of storage areas that are periodically flooded by overflowing streams, should be incorporated into catchment and flood risk management.
17. New concepts of channel management should be explored by the OPW regarding channel performance and channel management at multiple scales, i.e. local, reach and catchment scales. Channels form part of a dynamic system and channel management issues can reflect different scale processes. Therefore, it is important to understand and try to work with natural processes and challenge the need for intervention. These elements of channel management could also link in with existing Flood Risk Management Plans and River Basin Management Plans in a sustainable approach to catchment and channel management, which would further reduce potential impacts on Natura 2000 sites.
18. OPW have carried out training programmes in the past for their staff in relation to environment and ecology. OPW should provide further training and updates to all staff on a regular basis and in particular in relation to any updates to SOPs and Environmental studies.
19. To ensure compliance with the Birds and Habitats Directive, proposed arterial drainage maintenance activities should undergo an Appropriate Assessment at project level, based on final project design or the specifics of the programme elements. The other technical areas such as hydraulic, hydrological and hydrogeological impacts resulting from the proposed works at project level should also be considered in the Appropriate Assessment.
20. For some of the proposed arterial drainage activities the development of a Construction Environmental Management Plan (CEMP) will be important to include mitigation measures as part of the AA. The inclusion of a CEMP will safeguard the integrity of the Natura 2000 network of sites by minimising the potential for habitat loss, disturbance of species and potential adverse impacts on water quality/quantity dependant sites. The

CEMP will need to be site specific and relevant to the detailed design of the activity, including associated activities such as access to a channel and surface water runoff controls.

11.4 Residual Impacts with Recommended Mitigation Measures in Place

The assessment of implementing all of the recommended mitigation measures has been presented for each catchment in the tables in Volume IV: Appendix D. The recommended mitigation measures present opportunities for positive impacts over longer time periods and benefiting a wider area. Implementing these will result in a more sustainable approach to planning and delivery of maintenance activities.

The positive benefits to Natura 2000 sites and Habitats Directive Annexed habitats and species is unlikely to be greater than minor positive. These impacts could be widespread long term, especially for catchments where Natura 2000 sites cover long lengths of watercourses and estuaries.

12 Monitoring Measures

12.1 Introduction

Article 10 of the SEA Directive and the SEA Regulations requires that the responsible authority monitors the significant effects of the implementation of a plan or programme. The purpose of the monitoring programme is to identify unforeseen adverse effects at an early stage and undertake appropriate remedial actions. This is analogous to the approach suggested by JBA in this SEA; pre-maintenance assessment and post-maintenance assessment. The monitoring will provide a cross-check of the impacts.

The focus of the monitoring framework is to set out the measures that can be used by the OPW to monitor the implementation of the maintenance activities and the effects that this has on the environment.

The EPA's Catchment Portal (www.catchments.ie) can be used as a baseline for the environmental status of a habitat or waterbody during the planning stage of the five year and annual maintenance programme. The data and maps that are available on this website can be incorporated into the SEA monitoring programme. Monitoring requirements will also be conditioned on any wildlife licences or appropriate assessments for specific works.

The proposed draft Arterial Drainage Maintenance Activities 2016-2021 sets out what maintenance activities could occur on applicable channels, embankments and structures (see Table 3-1). A full monitoring programme for the draft activities is difficult to present at this stage because the actual maintenance activity to be carried out, when and with what mitigation measures is not determined until the five year, annual maintenance programmes are developed. In some cases, such as where Otters presence is identified during a pre-works inspection the need for mitigation measures or refinement in approach may not be specified until this point.

The recommended mitigation measures (see section 11) include proposed monitoring to build a scientific evidence base on:

a) the impacts of the Arterial Drainage Maintenance Activities 2016-2021, and
b) environmental change to assess how maintenance activities and the scheme elements should evolve and adapt over time.

The continued development of the scientific evidence base will be a valuable tool in the appropriate assessment of maintenance activities.

The table of the environmental objectives and target presented in Section 7 (Table 7-1) of this report identifies the indicators and monitoring requirements for the SEA. The table highlights the monitoring frequencies and responsibilities for collection of the monitoring data. Once captured this real time information can be used to update the baseline information presented in this report. The data can be used as a benchmark and trends identified can be used to show where SOPs may need updating or where new SOPs might be required. The monitoring programme should be aligned with the monitoring programme for other Plans and Programmes such as the CFRAM programme, WFD, and the EPA's fluvial geomorphological assessment programme. The similarity between many of the activities assessed here and the CFRAM Flood Risk Management Plan (FRMP) measures presents an opportunity for a cohesive approach to monitoring. In particular, this monitoring will inform the six yearly update of the FRMPs as is a requirement of the EU Floods Directive.

Section 15 of the Climate Action and Low Carbon Development Act, 2015 places a legal obligation for all Government Departments and Semi-State Bodies to reduce their carbon footprint. The capture of real time carbon dioxide emission data from the maintenance activities will help the OPW to build up a picture of their footprint and it will assist in measures to be put in place to reduce this.

It is recommended that all the monitoring data generated is stored in a centralised database that can be accessed nationally, and where appropriate shared with third parties. This information should be used to inform the 6-yearly update to the Arterial Drainage Maintenance Activities (2022-2027). The review should focus on:

- Have any significant impacts occurred during this period?
- What new data has been accumulated from other programmes during this timeframe and how has it being made available to the OPW
- What Plans/Programmes have been initiated during this period that could influence/impact on the maintenance activities
- How have the recommended mitigation measures in the SEA been integrated into the maintenance planning and delivery?
- Does the review of the monitoring data for this period highlight any changes/amendments that should be made to the Arterial Drainage Maintenance Activities or Flood Risk Management Plans?
- Has the monitoring assessed the adaptive capacity of arterial drainage schemes, channels, embankments and structures to climate and other future changes? Has this resulted in any change in the management approach? Are there any schemes, or parts of schemes, which will no longer be able to offer any flood protection of land drainage function in the future?
- Have any new approaches to flood risk management, land management and land drainage been identified within this period?
- What progress has been made with integrating Arterial Drainage Maintenance Activities 2016-2021 with other Plans and Programmes such as the CFRAM FRMPs, WFD, National Biodiversity Plan, Peatland Conservation Plans, Freshwater Pearl Mussel Conservation Plans etc.

13 Summary and Conclusion

13.1 Summary

In conclusion there are potential negative environmental, social and economic impacts of the draft Arterial Drainage Maintenance Activities (2016-2021). There are no viable alternatives that can be immediately implemented. This Environmental Report recommends a suite of mitigation measures which would result in a more sustainable approach to Arterial Drainage Maintenance. These mitigation measures relate to:

- M1: Improved Maintenance Planning (6-year annual plans).
- M2: Improved Standard Operating Procedures and Environmental Protocol
- M3: Monitoring of all Maintenance Activity with Continuous Improvement through Feedback into Methods and Approach.
- M4: Expansion of River Restoration and Environmental Enhancement
- M5: Asset Management and Climate Adaptation Planning
- M6: Monitoring of Environmental Conditions
- M7: Natural Flood Management, Working with Natural Processes and Land Management Practices

An Appropriate Assessment of the draft Arterial Drainage Maintenance Activities (2016-2021) was carried out as part of this Strategic Environmental Assessment and is detailed in Volume III: Arterial Drainage Maintenance Activities 2016-2021 SEA Natura Impact Statement.

13.2 What's Next?

The draft Arterial Drainage Maintenance Activities 2016-2021 and the accompanying SEA Environmental Report and Appropriate Assessment will be available for review and comment during a consultation period.

The draft Environmental Report will be available online at:

http://www.opw.ie/en/floodriskmanagement/operations/environmentalactivities/

All comments received on the draft Arterial Drainage Maintenance Activities 2016-2021 and the SEA Environmental Report will be reviewed. Any changes required will be made to the draft Arterial Drainage Maintenance Activities 2016-2021 and an assessment of these changes will be made by the SEA team. When the Arterial Drainage Maintenance Activities 2016-2021 are adopted an SEA Statement will be prepared. The SEA Statement will document the process, and identify how comments were addressed in the Arterial Drainage Maintenance Activities 2016-2021.

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A Consultation Submissions

Refer to Volume IV: Appendices.

B Summary of the plans, policies, and programmes of relevance to the draft Arterial Drainage Maintenance Activities (2016-2021)

Refer to Volume IV: Appendices.

C Assessment of Alternatives

Refer to Volume IV: Appendices.

D Catchment Assessment Tables

Refer to Volume IV: Appendices.

E Arterial Drainage Scheme, Embankment and Flood Relief Scheme Catchment Maps

Refer to Volume IV: Appendices.

Offices at
Dublin
Limerick

Registered Office
24 Grove Island
Corbally
Limerick
Ireland

t: +353 (0) 61 345463
e:info@jbaconsulting.ie

JBA Consulting Engineers and Scientists Limited
Registration number 444752

Visit our website
www.jbaconsulting.ie