

**SERIES OF ECOLOGICAL ASSESSMENTS ON
ARTERIAL DRAINAGE MAINTENANCE No 4**

**Ecological Impact Assessment (EcIA) of the
Effects of Statutory Arterial Drainage
Maintenance Activities on the Otter
(Lutra lutra)**



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Foreword

This Ecological Impact Assessment follows on from the strategic approach outlined in **“Series of Ecological Assessment on Arterial Drainage Maintenance No. 1: Screening of NATURA 2000 Sites for Impacts of Arterial Drainage Maintenance Operations.”**

It examines the impacts of statutory arterial drainage maintenance activities on the otter (*Lutra lutra*), outlines measures to mitigate any negative impacts, and possible enhancement opportunities.

Environment Section



The Office of Public Works Ecological Impact Assessment (EcIA) of the Effects of Statutory Arterial Drainage Maintenance Activities on the Otter (*Lutra lutra*)

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GLOSSARY

<i>Biodiversity</i>	The diversity of all life; faunal and floral.
<i>Connectivity</i>	How habitats are linked to one another to provide routes of travel for wildlife.
<i>Couch</i>	An above ground resting place for otter
<i>Crepuscular</i>	Refers to an animal which is mainly active during dawn and dusk hours
<i>Cubs</i>	Juvenile otters.
<i>Duration</i>	An Impact Assessment term; refers to the length of time an impact may last.
<i>Ecological Impact Assessment (EcIA)</i>	The formal process by which potential impacts on ecological factors are assessed as to their significance.
<i>Ecosystem</i>	The flora and fauna within a given area and how they interact with each other.
<i>Enhancement</i>	With reference to habitat, enhancement describes the improvement in terms of extent and species richness.
<i>European Sites</i>	Sites identified for protection under the EU Habitats and Birds Directive.
<i>Extent</i>	An Impact Assessment term, refers to the area over which an impact may occur.
<i>Fragmentation</i>	A term given to the isolation of habitat by removal of vegetation.
<i>Frequency</i>	An Impact Assessment term, refers to how often an impact may occur.
<i>Glides</i>	A 2-3cm sub-surface water movement.
<i>Holt</i>	An underground resting place of otters. Normally within tree roots immediately on the bank.
<i>Impact</i>	An effect on an ecological feature.
<i>Integrity</i>	The sustainability or wholeness of a site or feature.
<i>Keystone Species</i>	A species whose inclusion in an ecosystem has a major effect other species and habitats present.
<i>Lay-up</i>	An above ground resting place of otter.
<i>Linked</i>	With reference to habitats or species, linked reflects a relationship between the subject species and a further species.
<i>Magnitude</i>	An Impact Assessment term, refers to size or amount of an impact.
<i>Meta-population</i>	A group of discrete populations which may interact with each other.
<i>Mustelidae</i>	A taxonomic grouping to which otters belong.
<i>Natal Dens</i>	A holt used by otters to rear young.
<i>National Parks and Wildlife Service (NPWS)</i>	The statutory nature conservation organisation in Ireland.
<i>Natura 2000 Network.</i>	Refers to the collection of European designated sites; SACs and SPAs.
<i>Path</i>	An entrance to a water body used by otters.
<i>Probability</i>	An Impact Assessment term, refers to the likelihood that an impact may occur.
<i>Refuges</i>	Places where animals may shelter.
<i>Reversibility</i>	An Impact Assessment term, refers to whether an impact may be undone.
<i>Riffles</i>	A water movement which breaks the surface.
<i>Severance</i>	The process by which fragmentation of habitat occurs.
<i>Significance</i>	An Impact Assessment term, refers to whether an impact will have a large enough effect to require mitigation.
<i>Slide</i>	An entrance to a water body used by otters.
<i>Special Area of Conservation (SAC)</i>	A designation under the EU Habitat Directive. A constituent of The Natura 2000 Network.
<i>Special Protected Area (SPA)</i>	A designation under the EU Birds Directive. A constituent of The Natura 2000 Network.
<i>Spraint</i>	Otter faeces. Used by otter to mark territories and to communicate with each other.
<i>Sprainting Site</i>	A prominent feature used by otters for sprainting e.g. an in-stream boulder
<i>Tracks</i>	Diagnostic footprints of otters.

1. REMIT

This report was commissioned by the Office of Public Works, on the 13th June 2006, with respect to an Ecological Impact Assessment (EcIA) on the effects of statutory Arterial Drainage Maintenance activities on the European Otter (*Lutra lutra*) in Ireland.

The aim of the EcIA was to assess the potential impacts, both positive and negative, of the statutory Arterial Drainage Maintenance activities on the otter. The otter is a qualifying interest of 14 Special Areas of Conservation (SACs) in Ireland, within which Maintenance Activities are undertaken.

The aim has been achieved through the following objectives;

- Case studies of four representative SAC systems, including species surveys;
- Identification and research of maintenance activities; and
- Impact Assessment following Institute of Ecology and Environmental Management (IEEM) guidelines for Ecological Impact Assessment (2006)¹.

¹ Institute of Ecology and Environmental Management. Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM 2006).

2. EXECUTIVE SUMMARY

The EcIA, of impacts from Arterial Drainage Maintenance activities, on the otter, was based upon consultation with relevant parties, site visits, species surveys, and interpretation of maintenance activities, within four representative SAC systems.

Predictive assessments were then applied to the baseline conditions recorded, potential impacts identified, mitigation measures proposed as appropriate, and residual impacts assessed.

The application of field work identified; site use by otters, maintenance activities and potential impacts.

The potential impacts were identified and assessed as follows:

- Direct Habitat Loss;
- Severance;
- Loss of Life;
- Physical disturbance ;
- Noise disturbance; and
- Habitat creation.

All were assessed against guidance offered by IEEM.

Mitigation suggested to address these impacts included:

- Establish a clear understanding on the needs of otters and the relevance of different maintenance activities upon those needs;
- Training of front-line staff in the identification of otter field signs and resting places, or use specially trained professional consultants;
- Ongoing surveys to investigate site use by otters and monitor potential recovery time from maintenance activities;
- Adhere, develop and regularly assess the Environmental Drainage Maintenance (EDM) work practices;
- Where possible, mature trees and in-stream boulders should be retained;
- No use of heavy plant and use smaller work parties, where otters are known to be sheltering (informed by survey work);
- Regular communication with relevant nature conservation organisations, fisheries boards and rangers; and
- For future design, construction and maintenance of small bridges and culverts refer to the Design Manual for Roads and Bridges (DMRB).

Using IEEM guidelines an assessment was carried out of the potential impacts from maintenance activities on otters. The assessment concluded that the overall impact from the maintenance activities can be judged to range from a low significant impact (severance, physical disturbance and noise disturbance) to a significant positive impact (habitat creation).

3. INTRODUCTION

3.1 Historical Background and Functions of Statutory Arterial Drainage.

3.1.1 Historical Background

Drainage works have a long history in Ireland stretching back to the mid 19th century. Ireland by nature is liable to flooding and drainage problems principally due to the fact that the country has high rainfall, and a relatively low-lying interior surrounded by coastal highlands.

A large scale programme of catchment wide Arterial Drainage Schemes was carried out by the State between 1945 and 1995, and, following the 1995 Amendment to the 1945 Arterial Drainage Act, a number of flood relief schemes have been undertaken to mitigate, in the main, urban flooding.

There is a statutory obligation on the State to maintain these schemes "in proper repair and effective condition". The State exercises this responsibility through the Office of Public Works (OPW) which is now the State's Lead Agency in relation to flood management.

In recent years the OPW has become aware of the effects of its activities on the natural environment. The OPW recognises the need to fully understand the impacts of drainage maintenance operations with the aim of both minimising negative impacts and focusing through studies and research on identifying future positive impacts (OPW 2006).

3.1.2 Functions of Statutory Arterial Drainage

The main functions of the Statutory Arterial Drainage Schemes are to provide flood alleviation (freshwater and estuarine) and outfall for land drainage.

In total over 260,000 hectares of land has benefited from the 1945 Arterial Drainage Act schemes (OPW 2006).

3.2 Legal and Policy Context for this Ecological Impact Assessment

To ensure compliance with the EC Habitats Directive (Council Directive 92/43/EEC), transposed into Irish law through the European (Natural Habitat) Regulations (1997), the OPW is required to carry out environmental assessments for European Sites (Natura 2000 network), which overlap with drainage operations. European Sites under the Habitats Directive include Special Areas of Conservation (SACs) and Special Protected Areas (SPAs).

In accordance with Section 31 of the European Communities (Natural Habitat) Regulations 1997, where an operation or activity is carried out by the State that is likely to have a significant effect on a European Site, an appropriate assessment should be carried out on the implications for that site, in view of its conservation objectives. The operation or activity shall only be undertaken when it is ascertained that it will not adversely affect the integrity of the site and then, having regard to conclusions from the assessment (OPW 2006).

This assessment addresses those potential impacts which may affect otters in the sites investigated.

It is important to note that the designation process of SACs and SPAs commenced in Ireland after the Arterial Drainage Schemes. The designation process commenced in the mid 1990's and 1980's respectively and the national programmes of Arterial Drainage Schemes commenced in 1948 and finished in 1995. Therefore, all Natura designations are based on conservation factors in a post drainage scheme environment (OPW 2006).

3.3 Objective and Scope of Study

This study has been designed to assess the potential impacts of Arterial Drainage Maintenance activities on the otter. As such, the scope of the study has necessarily included an understanding and, where possible, an observation of all activities associated with maintenance. These activities are discussed further in Chapter 5 of this report.

Furthermore, as this study aims to address impacts at a national scale, the scope of study includes a geographical element in ensuring that samples have been taken across the country (4 catchments maintained by OPW).

During the development of the scope of study, an understanding of the volume of data required was addressed. It was considered by the OPW, that a representative selection of study areas, or case studies, would provide sufficient data. The rationale behind this included;

- That maintenance activities across the country are standardised;
- That complete studies of each SAC and associated drainage channels and tributaries would be extremely time-consuming and costly; and
- That the data gathered and EcIAs produced through complete surveys of each SAC, their drainage channels and tributaries would quickly become dated and irrelevant given that maintenance works is often carried out at intervals of up to a decade.

This understanding led to a scope of study which included an assessment of 4 representative SAC systems based on geographical location and maintenance activities currently being undertaken.

The selected SACs are detailed in Table 1, and are illustrated in Maps 1-5 in Appendix A of this report. Map 1 shows the SAC locations. Maps 2-5 show SAC boundaries, OPW scheme channels, site layout and field signs recorded during each survey.

Table 1: Assessment Sites

Site	Region	SAC/Code	OPW Channel Reference	Grid Reference
1	West	River Moy SAC (002298)	C1/21/1/5/18/3	M26121 77747
2	West	Lough Carra/Mask SAC (001774)	CM5/10	M20006 73803
3	South-West	Lower River Shannon SAC (002165) - Mulkear River	C1	R78710 49075
4	East	River Boyne and River Blackwater SAC (002299) - Athboy River	C1/21	072864 62917

3.4 Methodology

3.4.1 Field Work

As part of this study, surveys were undertaken within each case study area. Surveys were, where possible, undertaken while maintenance activities were underway. So as to provide a clearer understanding of site use by otters, surveys were also undertaken on sites where maintenance had recently taken place or was due to begin.

Surveys were undertaken in bright, dry conditions between the 19th & 20th of September and 10th & 11th of October 2006. Each survey took place following a sustained period of dry weather. This is an important aspect of otter surveying as heavy rain and high water levels often remove the field signs searched for, and can potentially produce false-negative results.

Surveying involved walking within the 4 representative SACs/OPW channels (C1/21/1/5/18/3, CM5/10, C1 and C1/21), and searching for field signs of otter. Searching for field evidence was extended to 1km in length and 5-10m either side of each watercourse, and through adjacent land zones.

Each survey followed methodology endorsed by NPWS and evidence searched for included:

- Spraints - Otter faeces/droppings used as territorial signposts. Often located in prominent positions and can be placed on deliberate piles of river soil or sand;
- Tracks - Diagnostic, five-toed track;
- Feeding remains - Can often be a useful indication of otter presence;
- Paths/Slides - Otter can often leave a distinctive path from and into the watercourse;
- Holts - Holts (underground shelter) are generally found:
 - Within trees roots at the edge of the bank of a river;
 - Within hollowed out trees;
 - In naturally formed holes in the river banks that can be easily extended;
 - Or preferably in ready-made holes created by other large mammals or humans such as Badgers setts, rabbit burrows or pipes; and
- Couches/lay-ups: Couches or lay-ups are places for lying up above ground are usually located near a watercourse, between rocks or boulders, under dense vegetation.

The main focus of survey in this case was placed on the presence of spraints, potential couches (as male otters rarely use holts), and actual or potential holts. This was primarily related to the

fact that spraints are a good way of telling whether there is fresh evidence of otter presence in the local area. Couches are used as places of shelter and holts are particularly important as maternity sites (and can be used for this purpose throughout the year).

In order to provide a complete understanding of the ecology of the site, the habitats in the vicinity of each survey area were also recorded.

As discussed field signs recorded during each survey are illustrated in Maps 2-5 in Appendix A, and full survey results, along with detailed habitat descriptions, are presented in Appendix B.

3.4.2 Assessment Methodology

The assessment has been undertaken following the guidelines produced by the Institute of Ecology and Environmental Management as described in the Remit section of this report. These Guidelines reflect current legislation and best practice relating to EcIA and species protection.

4. SPECIAL AREAS OF CONSERVATION

4.1 Description of the Conservation Aspect

4.1.1 Biology and Ecology

The otter is a member of the Mustelidae family (including stoats, weasels, and pine martens) and are found along rivers, burns, lochs and around coasts, feeding on a wide range of prey items including fish, crustaceans, amphibians, small mammals, and birds. The species inhabits large territories (c. 20km), seeking out the best foraging opportunities at the most appropriate time of the year.

Within the territory there will be a number of actively used den sites or holts. Some of these will be favoured as natal dens by the females. Holts can be found directly on the bank in large holes, within the root systems of overhanging trees, or anywhere that provides shelter and security. They are also known to use certain places to rest-up temporarily, for example, under cover of the bankside vegetation, the roots of a tree or under rock piles etc. These rest places are known as couches or lay-ups.

The otter can breed at any time of the year, producing between one and five cubs in a litter and generally an average of two. The natal dens can be found above or below ground depending on the conditions at the breeding site, and can be located in dense scrub, within hollow trees, in piles of rubble or rocks, rabbit holes, fox dens; anywhere where there is good cover and protection. The young are not fully weaned until approximately the third month, and they stay with their mother for about twelve months.

4.1.2 Distribution

Ireland has long been considered to hold one of the most important otter populations remaining in Western Europe (Whilde 1993), following a rapid and widespread decline during the 1960s and 1970s. This decline was caused by pollution through the use of organochloride insecticides coupled with hunting and habitat loss.

Surveys carried out in the early 1980s (Chapman and Chapman 1982), in the early 1990s (Lunnon and Reynolds 1991), and again between 2004 and 2005 (Bailey and Rochford 2006) confirmed the species had recovered, and appeared to be widespread throughout the country, in freshwater and coastal environments (Bailey and Rochford 2006).

4.1.3 Legislation

As a result of the widespread decline in otter populations (as discussed above) and the possible continued threats to the species from habitat loss, disturbance and pollution, the otter is protected under the following legislation:

- EC Habitats Directive as enacted in Ireland through the European (Natural Habitat) Regulations (1997);
- The Wildlife Acts of 1976 and 2000; and
- The Bern Convention (1979).

Furthermore, the species is listed in the Red Data book as being of 'vulnerable' conservation status.

Regulation 23 of the European (Natural Habitat) Regulations (1997) makes it a criminal offence to:

- Deliberately catch or kill an otter in the wild;
- Disturb an otter, particularly during breeding and rearing; and
- Destroy or deteriorate a breeding site or resting place of an otter.

Section 23 of the Wildlife Act 1976, makes it a criminal offence to:

- Hunt a wild otter without licence;
- Injure a wild otter; and
- Wilfully interfere or disturb an otter breeding site.

Where any required work would result in disturbance to an active otter holt or couch it would be necessary for the developer to apply for a licence through NPWS and/or the Irish Environment Protection Agency (EPA) to carry out that work. Work within 100m of an active holt, which may cause disturbance, would be considered an offence under the legislation described above. This will be addressed in further sections of this report.

4.1.4 Conservation

Article 3 of the Habitats Directive requires the establishment of a European network of important high quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified of Annexes I and II of the Directive. This network, named Natura 2000, consists of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

Ireland has designated approximately 400 SACs, of which 44 have been designated for the otter. In addition to designating SACs, however, Article 11 of the Directive requires that:

"Member States shall undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2..."

Article 2 includes the otter, hence Article 11 places a duty on the State to monitor the conservation status of this species.

4.2 Site Evaluations

4.2.1 Site Value

Site evaluation is an important aspect of any EcIA as it places in context the nature conservation value of the site concerned. Following guidance provided by the IEEM on the determination of site value; any site currently designated as a SAC is of international value.

Given that otters are a qualifying feature of the SACs in question, each site assessed in this document and indeed each SAC with otter interests is of **international** value. This evaluation will be important in the forthcoming assessment of impacts.

4.2.2 Background Information

In the interest of completeness, this section describes the background in terms of biology, geology, geography and land use of the SACs selected as part of this study.

4.2.2.1 River Moy SAC (00298)

The River Moy SAC (00298) comprises almost the entire freshwater element of the Moy and its tributaries including both Loughs Conn and Cullin. The system drains a catchment area of 805 sq. km. Most of the site is in Co. Mayo though parts are in west Sligo and north Roscommon. Apart from the Moy itself, other rivers associated with the site include the Deel, Bar Deela, Castlehill, and Addergoole on the west side and the Glenree, Yellow, Strade, Gweestion and Trimogue on the east side. The underlying geology is Carboniferous limestone for the most part.

Agriculture, with particular emphasis on grazing, is the main landuse along the Moy. Much of the grassland is unimproved but with improved grassland and silage (NPWS 2005).

The site is an SAC selected for alluvial wet woodlands and raised bog, both priority habitats on Annex I of the EU Habitats Directive. The site is also an SAC selected for old oak woodlands, degraded raised bog and *Rhynchosporion*, all habitats listed on Annex I of the E.U. Habitats Directive. Furthermore, the site is selected for Atlantic salmon (*Salmo salar*), otter (*Lutra lutra*), sea and brook lamprey (*Petromyzon marinus* and *Lampetra planeri*) and white-clawed crayfish (*Austropotamobius pallipes*) (NPWS 2005).

4.2.2.2 Lough Carra / Mask SAC (001774)

The Lough Carra / Mask SAC (001774) is dominated by two large lakes, Lough Mask and Lough Carra, and includes the smaller Cloon Lough. On the western side, the site is overlooked by the Partry Mountains, while to the east the landscape is largely low-lying agricultural land. The general geological character of the area is Carboniferous limestone, with some shales and sandstones on the western side of Lough Mask. The underlying geology results in a great diversity of habitats, which support many scarce and rare plants and animals. Lough Mask, at over 8,000 ha, is the sixth largest lake in the country and with a maximum depth of 58m it is one of the deepest. It is an excellent example of a lowland oligotrophic lake. Lough Carra, which is hydrologically linked to Mask, is one of the best examples in Ireland of a hard water marl lake. It is a shallow (mostly less than 2 m) predominantly spring fed lake with only a few streams, including OPW channel (CM5/10) flowing into it (NPWS 2005).

This site is of considerable conservation importance as it has good examples of six habitats listed on Annex I of the EU Habitats Directive: lowland oligotrophic lakes, marl lakes, limestone pavement, dry heath, *Cladium* fen and alkaline fen. Some of these habitats are amongst the best examples of their kind in the country. It also has two Annex II mammal species, otter and pine marten (*Martes martes*) and an Annex II invertebrate. The site is of ornithological

importance for both wintering and breeding birds, with three Annex I Bird Directive species occurring regularly. A relatively large number of other nationally rare or localised plant and animal species occur, including the glacial relict Arctic char (*Salvelinus alpinus*) (NPWS 2005).

4.2.2.3 Lower River Shannon SAC (002165)

The Lower River Shannon SAC (002165) is a very large site that stretches along the Shannon valley from Killaloe to Loop Head/Kerry Head, a distance of some 120 km. The site thus encompasses the Shannon, Feale, Mulkear and Fergus Estuaries, the freshwater lower reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. Rivers within the sub-catchment of the Mulkear include the Killeenagarraff, Annagh, Newport, the Dead River, the Bilboa, Glashacloonaraveela, Gortnageragh and Cahemahallia (NPWS 2005).

There is a wide range of landuses within the site. The most common use of the terrestrial area is grazing by cattle and some areas have been damaged through over-grazing and poaching (NPWS 2005).

The site is an SAC selected for lagoons and alluvial wet woodlands, both habitats listed on Annex I of the EU Habitats Directive. The site is also selected for floating river vegetation, *Molinia* meadows, estuaries, tidal mudflats, Atlantic salt meadows, Mediterranean salt meadows, *Salicornia* mudflats, sand banks, perennial vegetation of stony banks, sea cliffs, reefs and large shallow inlets and bays all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive: Bottle-nosed dolphin (*Tursiops truncatus*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), brook lamprey (*Lampetra planeri*), freshwater pearl mussel (*Margaritifera margaritifera*), and Atlantic salmon (*Salmo salar*) (NPWS 2005).

4.2.2.4 River Boyne and River Blackwater SAC (002299)

The Boyne and River Blackwater SAC (002299) is a site that comprises the freshwater element of the River Boyne as far as the Boyne Aqueduct, the Blackwater as far as Lough Ramor and the Boyne tributaries including the Deel, Stoneyford and Tremblestown Rivers (Athboy River is a tributary of the Tremblestown River). These riverine stretches drain a considerable area of Meath and Westmeath and smaller areas of Cavan and Louth. The underlying geology is Carboniferous limestone for the most part.

The site is an SAC selected for alkaline fen and alluvial woodlands, both habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive: Atlantic salmon (*Salmo salar*), otter (*Lutra lutra*) and river lamprey (*Lampetra fluviatilis*) (NPWS 2005).

4.3 Site Integrity

Under the European (Natural Habitat) Regulations (1997) in relation to SACs, works shall not normally be permitted when they will negatively affect the 'integrity' of the site. The 'integrity' of

a site refers to an approach which deals with the whole ecosystem. 'Integrity' is best described as,

'...the coherence of [the site's] ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified.'

Conservation objectives for SACs usually include the following:

- To avoid deterioration of the habitats of qualifying species, or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying feature; and
- To ensure for the qualifying species that the following are maintained in the long-term:
 1. Population of the species as a viable component of the site;
 2. Distribution of the species within the site;
 3. Distribution and extent of habitats supporting species;
 4. Structure, function and supporting processes of habitats supporting the species; and
 5. No significant disturbance of the species.

To ensure that the obligations of the Directive are met, there should not be deterioration or significant disturbance of the qualifying feature from its condition at the time the site is first given formal Ministerial approval.

4.4 Other or Linked Environmentally Sensitive Aspects

As discussed in section 3.3, the four representative SACs have been selected for various habitats and species (including otter). These selected habitats and species are listed on Annex I and Annex II of the EU Habitats Directive respectively.

A summary of other linked habitats and species for each SAC is presented in Table 2.

Table 2: Other and Linked Sensitive Aspects

SAC/Code	Habitats and Species
River Moy SAC (O02298)	<ul style="list-style-type: none"> • Alluvial wet woodlands and raised bog; • Old oak woodlands, degraded raised bog and <i>Rhynchosporion</i>; • Atlantic salmon*; • Sea and brook lamprey*; • White-clawed crayfish*.
Lough Carra/Mask SAC (001774)	<ul style="list-style-type: none"> • Lowland oligotrophic lakes; • Marl lakes; • Limestone pavement; • Dry heath; • <i>Cladium</i> and alkaline fen; • Annex II mammal species; and • Annex II invertebrate*.
Lower River Shannon SAC (002165)	<ul style="list-style-type: none"> • Lagoons and alluvial wet woodlands; • Floating river vegetation; • <i>Molinia</i> meadows; • Estuaries; • Tidal mudflats; • Atlantic salt meadows; • Mediterranean salt meadows; • <i>Salicornia</i> mudflats; • Sand banks; • Perennial vegetation of stony banks; • Sea cliffs; • Reefs; • Large shallow inlets and bays ; • Bottle-nosed dolphin; • Sea, river and brook Lamprey*; • Freshwater pearl mussel*; • Atlantic salmon*;
River Boyne and River Blackwater SAC (002299)	<ul style="list-style-type: none"> • Alkaline fen; • Alluvial woodlands; • Atlantic salmon*; • River lamprey*.

* Directly linked environmentally sensitive aspects (associated habitat and potential food source for otter)

5. MAINTENANCE ACTIVITIES CARRIED OUT BY THE OPW

5.1 Outline of Maintenance Activities

5.1.1 Historical Scheme Works

5.1.1.1 Scheme Works

Construction of the original Arterial Drainage Schemes required major hard engineering. Typically it involved widening and deepening the existing channel with some localised straightening and, in a few cases, the opening of a new channel reach. Using Draglines, works entailed excavation of all soil types such as peat, clays and gravel while rock was normally blasted. The channel cross section was excavated to a trapezoidal form, channel width was standardised, longitudinal gradients were made more uniform and cross sectional bed levels were made even. All in-stream and riparian vegetation and soils were removed and access for construction plant was made along the channel banks. In schemes prior to circa 1973, excavated material was stockpiled in spoil heaps setback parallel to the channel. Post 1973, the spoil was levelled out on riparian lands and damaged lands were top-soiled and reseeded (OPW 2006).

5.1.1.2 Scheme Hydrological Change

Typically the riparian water table would have been dropped by circa 1 metre although this value would vary widely depending on a number of characteristics such as soils, geology, topography, catchment hydrology and critical design factors. Arterial drained channels differ from more natural channels in that the waterway has significantly more uniform flow velocities, more constant depth/width ratios, a reduction in connectivity to floodplains but with more in-stream storage (OPW 2006).

5.1.2 Maintenance Works

The purpose of Arterial Drainage Maintenance is simply to retain the scheme channel's design capacity to convey water in an effective manner. Maintenance works are carried out following OPW environmental work practices through which ecological disturbance is minimised and habitat enhancement is common. Following the scheme works, the channel capacity gradually reduces over time as both silt and vegetation levels increase and other obstructions develop, necessitating maintenance to return the channel capacity to its design condition. This is achieved by removal of the silt and vegetation, repairing bank damage or slippage and removal of obstructions such as trees encroaching at low levels on the banks. No excavations of virgin ground are necessary and generally the majority of the riparian vegetation is left intact.

Maintenance works restore the hydraulic capacity of the channel to that originally designed. As a rule, medium to high gradient channels have limited build up of silt, and maintenance work consists of removing obstructions, repairing damaged banks and removal of dense in stream vegetation.

Low gradient channels requiring maintenance would normally have a reduced capacity due primarily due to siltation and in stream vegetation. Maintenance operations will reinstate the original design datum.

This ongoing process of maintenance ensures that the level of drainage provided to the riparian lands and the flood protection originally provided is retained.

5.1.2.1 Channel Works

As stated channel maintenance operations normally involve removing the build up of foreign or natural materials that impede the free flow of water. Predominately this consists of the removal of silt and vegetation from the bed of the channel by suitably rigged hydraulic excavators. Restrictions in channels due to bank slippage or damage would be re-graded to the original profile. Channel breaches due to bank erosion would be resolved by re-profiling the bank in-situ or in some cases by importing protection material such as rock armour or log poles. In addition, other larger vegetation such as trees, which impinge on channel capacity are either removed in whole or impingement is reduced by selective removal of lower branches. The material removed during maintenance operations is normally spread along the bank or on top of existing spoil heaps where present. In most cases, no alterations to the bank are required and in some cases the channel is not disturbed at all if no build up of material is present (OPW 2006).

Some channels that are steep and fast flowing are subject to flash floods, bank erosion and rapid movement of bed gravel. However, 60-70% of scheme channels are of gentle longitudinal gradient and subject to relatively rapid deposition of silt, especially those that are subject to prolific growth of in stream vegetation. The steeper sections of channel normally require relatively little maintenance works. The majority of maintenance works are on smaller lower lying channels with 90% of works in channels with a base width of less than three metres. The average channel requires maintenance every 4-6 years. Channels with prolific weed growth may require maintenance annually particularly where downstream urban bridges are at risk of being blocked due to a flow of decaying vegetation in the autumn. Conversely, some channels may only require maintenance every 20 years due to the self cleaning characteristics of the channel (OPW 2006).

5.1.2.2 Weed Cutting

A number of channels have an annual prolific growth of aquatic plants but are too wide or the bank conditions are too unstable to allow maintenance by way of excavators, even those designed for low ground pressure and long reach. Weed cutting boats are engaged in these cases. In all, ~90 km of channel are cleaned annually by four weed cutting boats, operating on a seasonal basis, with the majority of the works concentrated in the West of Ireland (OPW 2006).

5.1.2.3 Embankments

Most embankment schemes are tidal in nature hence they tend to be located at estuaries. The foremost inland embankment scheme is the Annagh Embankments on the Inny Drainage Scheme. The frequency of maintenance for embankments tends to be more variable than that

for channels. Embankments are scheduled for works when it is deemed that the structure is in need of repair to maintain an effective condition. Repair work normally takes the form of topping up clay embankments to design height and structural strengthening by importing rock/soil material or utilising in-situ material that has been eroded from the original embankment (OPW 2006).

5.1.2.4 Other Works

Included within the 18,500 bridges in Ireland on maintainable arterial drainage schemes are structures ranging from concrete pipe culverts, timber bog access ramparts through to concrete or masonry abutments either with a similar decking material or steel girders with concrete or timber decking. Repair / replacement works are carried out on ~ 170 bridges per annum and are restricted to the most critical structures. Repair works are normally carried out with a similar material as that of the structure in question with the exception of the wooden structures that tend to be substantially deteriorated and are replaced by concrete structures (OPW 2006).

Ancillary structures such as sluice gates, tidal barrages and pumping stations are repaired or replaced as necessary to maintain their respective operating function (OPW 2006).

5.2 Extent of Interference

The extent of interference from maintenance activities is dependent on the type and frequency of maintenance activities required. As an indication, Table 3 below provides information on those channels surveyed, the activities carried out and the frequency of these works.

'extent' is a factor for consideration within an impact assessment and has been given formal consideration in further chapters of this report.

Table 3: Maintenance Activity Timing

Site (Channel)	Maintenance Activity	Frequency of Maintenance Activity	Scale of site
1 (C1/21/1/5/18/3)	Channel works by hydraulic excavator (bank) Note: C1/21/1/5/18 the adjoining Meander River is a 10km channel.	Every 6 years	1.3 km
2 (CM5/10)	Weed cutting by boat Note: Typically only first 1.5km of channel is weed cut annually. This is the segment approaching Lough Carra and is subject to prolific in-stream growth. Upstream 4.0km maintained circa 4 years.	Every year	5.5 km
3 (C1)	Channel works by hydraulic excavator (in-stream and bank)	Every 8 years	11 km
4 (C1/21)	Channel works by hydraulic excavator (bank) Note: In long channels like this, maintenance is normally carried out in sections with entire channel being completed over a number of years.	Every 7 years	35 km

5.3 Duration and Timing of Maintenance Activities

The duration of timing of drainage maintenance activities is dependent on what works are required and site specific characteristics

As discussed in section 5 maintenance activities carried out by the OPW include scheme works, channel works, weed cutting, embankment works, and upholding of bridges and culverts. From the complex nature and different methodologies that are required to undertake these activities, it is clear that the duration and timing of works will vary. As discussed, the average channel requires maintenance every 4-6 years, channels with prolific weed growth may require annual maintenance, and some self cleaning channels only require maintenance every 20 years (OPW 2006).

As with extent, 'duration' and 'timing' are factors which require formal consideration within the impact assessment. These factors have been addressed in further chapters of this report.

5.4 Impacts on Sensitive Aspects

Based on a sound understanding of the maintenance activities required on drainage channels, coupled with knowledge of otter ecology, the following impacts are predicted as a result of maintenance activities:

- Direct Habitat Loss;
- Severance;
- Loss of Life;
- Physical Disturbance; and
- Noise Disturbance.

An important aspect of an Ecological Impact Assessment is also to highlight where positive impacts can be made or are already being undertaken. As such, it is considered that the habitat creation and enhancement associated with maintenance activities can have an indirect impact on otters.

6. EFFECTS OF THE MAINTENANCE OPERATIONS

6.1 Impact Assessment

This section of the report details an assessment of the impacts identified in section 5.4 above. This assessment has been based on guidance offered by IEEM in the recently published Guidelines for Ecological Impact Assessment in the United Kingdom (2006). Although this text has not been prepared specifically for Ireland, it provides details of best practice and current thinking which relates directly to the assessment of flora and fauna in Ireland.

Please refer to Chapter 4 (p30) of these guidelines for further information regarding the assessment of ecological impacts.

6.1.1 Direct Habitat Loss

Direct habitat loss describes the removal or destruction of any suitable substrate or vegetation used for shelter and/or foraging by the otter.

With regard to the maintenance works undertaken by the OPW, there will occasionally be some loss of riparian habitat, which provides suitable foraging, sheltering and breeding opportunities for otters. Maintenance activities which will result in this loss include: the clearing of marginal riparian vegetation; thinning of shrubbery or branches where they project into the channel and the deposition of spoil on banks, including the use of excavators to do so. Exceptionally, the need to remove woody vegetation may also arise.

This loss and disturbance will have a **negative** impact on otter populations, the likelihood of which is **certain**. The **magnitude** and **extent** of the impact is difficult to assess without population data for all sites and it will be dependent upon the operation being carried out, however it is likely that direct habitat loss will affect the available territory occupied by an otter, which will have ramifications on population dynamics throughout the SAC systems.

The **duration** of activities which lead to habitat loss, in terms of the actual activity, is generally limited and may only last a few hours to a few days. For larger catchments, with extensive weed growth, the duration of required activities is extended. Under these circumstances, the resultant impact of the habitat loss will have a much longer duration, for example it may impact on the breeding success of an otter which has lost a holt or lay-up site as a result of activities.

The impact of habitat loss is **reversible** (temporary) as, due to the long timescales associated with maintenance activities, substantial vegetation cover is allowed to re-grow prior to further maintenance works. This regenerated habitat may provide suitable cover and foraging opportunities for otters, particularly as prey species re-colonise these areas.

As described above, the **frequency** of habitat loss is varied and intermittent.

It should also be considered that maintenance activities are already managed with ecological interests in mind, and have been adapted to address these features where possible.

Given that each site in question is an SAC, and that otters are qualifying interests for each, it is assessed that the direct habitat loss is of **moderate significance**.

It should be noted that any works that will directly disturb otter holts or lay-up areas will require a licence under the European (Natural Habitat) Regulations (1997).

6.1.2 Severance

Severance describes the loss of connectivity between habitats, which ultimately results in the isolation of discrete populations of otters. Such isolation would result in an impact on the structure and function of a population.

Severance will be a **negative** impact, **magnitude** and **extent** are widespread but difficult to assess given the nature of the project. The **duration** of this impact would be fairly long-term given that cleared vegetation would take time to return. However any severance would be **reversible** as this vegetation would regenerate.

An assessment, such as this, should consider current practices. It should be noted that OPW maintenance works have been designed to limit damage to banks and, as such, now operate from one bank only, thus leaving vegetation on the opposite bank in tact. This approach would make total severance **extremely unlikely** as a green corridor will always be available.

Furthermore, the nature of otter territoriality is such that up to 20km constitutes a territory, thus further limiting the impact of severance. It has consequently been assessed that severance is of **low significance** with regard to otters.

6.1.3 Loss of Life

Loss of life refers to death of otters attributable directly to the maintenance works.

With regard to OPW maintenance activities, loss of life would be likely to occur during the undertaking of maintenance works, operation of plant, and through improper design, construction and maintenance of small bridges and culverts (with otters forced to cross roads because of poorly designed or built crossing structures).

Obviously, loss of life would be a **negative** impact, however as otters are largely territorial and occupy lay-ups and holts individually, the **magnitude** and **extent** would be very limited. Due regard, however, should be given to natal dens where cubs could be killed or orphaned through maintenance activities.

Although the loss of life of an individual otter would have a very short **duration**, longer term implications would include failed breeding opportunities or death of dependent cubs. Furthermore, the loss of life would be **irreversible**.

It should also be considered that otters are highly mobile animals with a network of holts and lay-ups within their territory. An individual without cubs would be capable of escaping any damage to their sheltering area.

Consequently, loss of life has been assessed as being of **moderate significance**, and of potentially **high significance** during the breeding season. This impact is considered to be **probable**.

6.1.4 Physical Disturbance

Physical disturbance refers to disturbance to otters caused by machinery or human activity. This classification may refer to disruption caused by the vibration of plant or by the presence of work teams. Physical disturbance may also be caused by high levels of activity during the otter's most active periods of the day.

Physical disturbance would result in a **negative** impact, with the impact **magnitude** and **extent** including all areas where activities are undertaken.

The **extent** would be limited to those times when plant and work teams were in operation and the impact would be **reversible** depending on the activity taking place, the size of plant and the number of members in the work party.

It should be considered that otters are crepuscular animals. That is to say that they are most active at dawn and dusk. Current practice dictates that maintenance activities are undertaken during full daylight hours. This would suggest that physical disturbance would not be a factor during the hours when otters are foraging; arguably the most important time of the otter's day, however it would be of **low significance** while otters were resting in holts and lay-ups. Significance would potentially be higher while females are rearing cubs, because it would be more difficult for a female to move cubs than say a male to move resting locations.

This impact is considered to be **probable**.

6.1.5 Noise Disturbance

As with physical disturbance, noise disturbance would impact on otters in those ways described above. Similarly, noise disturbance can be assessed as being of **low significance**. As above, this significance would be higher while females are rearing cubs.

This impact is considered to be **probable**.

6.1.6 Habitat Creation

By its nature, the creation of a drainage channel scheme across Ireland greatly enhanced the available habitat for otters. The maintenance activities, although resulting in the negative impacts above, also result in the maintenance of habitats suitable for otters. Through managing growth in-stream and bankside vegetation, maintenance works ensure that the water is suitable for fish species, which provide a valuable food source for otters. Furthermore, the management

of silt build-up through in-channel works and importation of suitably sized gravels, ensures suitable spawning grounds are available for fish.

This is a **positive** impact with an **extent** and **magnitude** equivalent to the size of the drainage network. It is also an impact of long-term **duration**. The continued management of these physical factors lead to a **certain** impact.

6.2 Changes in Site Integrity

The integrity of each SAC, River Moy, Lough Carra/Mask, Lower River Shannon and River Boyne & River Blackwater SAC's, applies to the conservation features for each site (otter). For the conservation objectives of the SAC to be met, the following ecological parameters must be considered: (i) population of the otter must remain as a viable component of the site; (ii) distribution of the otter must remain within the site; (iii) distribution and extent of habitats supporting otter must remain; (iv) the structure, function and supporting processes of habitats supporting otter must remain; and (v) there must be no significant disturbance of the otter.

The impacts of OPW's activities in terms of (i) Habitat Loss, (ii) Severance, (iii) Loss of Life, (iv) Physical Disturbance, (v) Noise Disturbance, and (vi) Habitat Creation must be considered against the conservation objectives above. Adoption of the mitigation measures outlined in Section 7 should ensure that integrity is not affected. However, failure to adopt the outlined mitigation measures means that site integrity cannot be guaranteed.

6.3 River Corridor Upstream, On Site and Downstream

A full river corridor survey was not carried out as part of this study. However, as part of the detailed otter survey, riparian and in-stream features were recorded at each site. For habitat descriptions and features identified of each survey, refer to Appendix B.

7. MITIGATION MEASURES

7.1 Avoidance Measures

Previous sections have identified that some maintenance activities undertaken by the OPW have a potentially significant (detrimental) impact on otter populations, whilst others may have potentially significant (beneficial) impacts on otter populations (outlined in 7.2).

7.1.1 Direct Habitat Loss

Mitigation to avoid direct habitat loss includes:

- Training of front-line staff in the identification of otter field signs and resting places, or preferably, the use of specially trained professional consultants.
- In instances where proposed works may interfere with riparian otter habitat, consultation with the NPWS should be undertaken. If then advised to do undertake an otter survey, the survey should be undertaken ca. two weeks prior to work commencing, during periods of suitable weather when otter signs are visible, in order to assess the need for disturbance licences. If surveys are carried out after a period of heavy rain and during high water levels, few signs will be visible and surveyors may inadvertently produce 'false-negative' searches, potentially leaving otters in harms way;
- Ideally, surveys should also be conducted following maintenance activities to investigate site use by otters, and to monitor potential recovery time from maintenance activities. From this potential impacts can be quantified in more detail than is currently possible;
- Adhere, develop and regularly assess the EDM Work Practices (developed by OPW and detailed below). For direct habitat loss this specifically refers to EDM steps 1, 2, 4 and 5, as described in section 7.2.;
- Where possible, mature trees within the river corridor should be retained. Similarly, large in-stream boulders and substrate should be retained where possible;
- No use of heavy plant and use smaller work parties, where otters are known to be sheltering (informed by survey work); and
- Regular communication should be maintained with the relevant nature conservation organisations, fisheries boards and countryside ranger teams who should review the annual works programme.

7.1.2 Severance

Mitigation to avoid severance includes:

- Training of front-line staff in the identification of otter field signs and resting places, or preferably, the use of specially trained professional consultants.
- In instances where proposed works may interfere with riparian otter habitat, consultation with the NPWS should be undertaken. If then advised to do undertake an otter survey, the survey should be undertaken ca. two weeks prior to work commencing, during periods of suitable weather when otter signs are visible, in order to assess the need for disturbance licences. If surveys are carried out after a period of heavy rain and during high water levels, few signs will be visible and surveyors may inadvertently produce 'false-negative' searches, potentially leaving otters in harms way;

- Adhere, develop and regularly assess the EDM Work Practices (developed by OPW and detailed below). For severance this specifically refers to EDM steps 1, 2, 3 and 4 as described in section 7.2.;
- Where possible, mature trees within the river corridor should be retained. Similarly, large in-stream boulders and substrate should be retained where possible;
- Regular communication should be maintained with the relevant nature conservation organisations, fisheries boards and countryside ranger teams who should review the annual works programme; and
- For future design, construction and maintenance of small bridges and culverts refer to the Design Manual for Roads and Bridges (DMRB)².

7.1.3 Loss of life

Mitigation to avoid loss of life includes:

- Training of front-line staff in the identification of otter field signs and resting places, or preferably, the use of specially trained professional consultants.
- In instances where proposed works may interfere with riparian otter habitat, consultation with the NPWS should be undertaken. If then advised to do undertake an otter survey, the survey should be undertaken ca. two weeks prior to work commencing, during periods of suitable weather when otter signs are visible, in order to assess the need for disturbance licences. If surveys are carried out after a period of heavy rain and during high water levels, few signs will be visible and surveyors may inadvertently produce 'false-negative' searches, potentially leaving otters in harms way;
- Adhere, develop and regularly assess the EDM Work Practices (developed by OPW and detailed below). For loss of life this specifically refers to EDM steps 4, as described in section 7.2.;
- No use of heavy plant and use smaller work parties, where otters are known to be sheltering (informed by survey work);
- Regular communication should be maintained with the relevant nature conservation organisations, fisheries boards and countryside ranger teams who should review the annual works programme; and
- For future design, construction and maintenance of small bridges and culverts refer to the Design Manual for Roads and Bridges (DMRB)³.

7.1.4 Physical disturbance

Mitigation to avoid physical disturbance includes:

- Training of front-line staff in the identification of otter field signs and resting places, or preferably, the use of specially trained professional consultants.
- In instances where proposed works may interfere with riparian otter habitat, consultation with the NPWS should be undertaken. If then advised to do undertake an otter survey, the survey should be undertaken ca. two weeks prior to work commencing, during periods of suitable weather when otter signs are visible, in order to assess the

² Design manual for roads and bridges (DMRB). Volume 10, Section 4 Environmental Design and Management Nature Conservation. Part 4 ha81/99 Nature conservation advice in relation to Otters.

need for disturbance licences. If surveys are carried out after a period of heavy rain and during high water levels, few signs will be visible and surveyors may inadvertently produce 'false-negative' searches, potentially leaving otters in harms way;

- Adhere, develop and regularly assess the EDM Work Practices (developed by OPW and detailed below). For physical disturbance this specifically refers to EDM steps 3 and 4, as described in section 7.2.;
- Where possible, mature trees within the river corridor should be retained. Similarly, large in-stream boulders and substrate should be retained where possible;
- No use of heavy plant and use smaller work parties, where otters are known to be sheltering (informed by survey work);
- Regular communication should be maintained with the relevant nature conservation organisations, fisheries boards and countryside ranger teams who should review the annual works programme; and
- To ensure high water quality, guidance on this subject developed by relevant agencies such as the Environment and Heritage Service (NI) and Environmental Protection Agency (EPA), amongst others, should be maintained.

7.1.5 Noise disturbance

Mitigation to avoid noise disturbance includes:

- Training of front-line staff in the identification of otter field signs and resting places, or preferably, the use of specially trained professional consultants.
- In instances where proposed works may interfere with riparian otter habitat, consultation with the NPWS should be undertaken. If then advised to do undertake an otter survey, the survey should be undertaken ca. two weeks prior to work commencing, during periods of suitable weather when otter signs are visible, in order to assess the need for disturbance licences. If surveys are carried out after a period of heavy rain and during high water levels, few signs will be visible and surveyors may inadvertently produce 'false-negative' searches, potentially leaving otters in harms way;
- Adhere, develop and regularly assess the EDM Work Practices (developed by OPW and detailed below). For noise disturbance this specifically refers to EDM steps 3 and 4, as described in section 7.2.;
- No use of heavy plant and use smaller work parties, where otters are known to be sheltering (informed by survey work); and
- Regular communication should be maintained with the relevant nature conservation organisations, fisheries boards and countryside ranger teams who should review the annual works programme.

7.2 Influence of EDM Work Practices

The EDM Work Practices were produced in July 2003 to ensure that the environment was protected during maintenance activities.

³ Design manual for roads and bridges (DMRB). Volume 10, Section 4 Environmental Design and Management Nature Conservation. Part 4 ha81/99 Nature conservation advice in relation to Otters.

An important feature of these Work Practices was the production of a Guidance Note, issued to all ground staff. The Guidance Note details "10 steps to Environmentally Friendly Maintenance". Six of these steps significantly lessen the potential impacts of maintenance activities on otters.

These include:

1. Protect bank slopes (retain vegetation on non working bank and minimise scraping of bank slope on working bank) - This will ensure that riparian habitat is permanently available for otters, thus providing potential breeding and sheltering opportunities;
2. Restrict maintenance to channel (remove in-stream material only and retain marginal vegetation) - This will ensure that riparian habitat is permanently available for otters, thus providing potential cover when entering and exiting the water, shelter and improved foraging conditions;
3. Leave section untouched (if channel capacity is not effected, then leave intact and only maintain if environmental works are required) - This will ensure that unnecessary impacts are avoided, and overall potential impacts on otter will be minimised;
4. Management of trees (leave intact if no reduction in channel capacity is caused, remove overhanging branches to flood level and use a saw or secateurs for removal, not an excavator) – This will ensure that suitable riparian habitat, for otters, will not be removed unnecessarily, and potential destructive impacts on otter sites from machinery will be avoided;
5. Replace boulders (reinstate boulders and gravels as removed by maintenance operations, reinstate boulders into channel from spoil heaps, and place boulders below low flow level and staggered) - This will ensure that features are available for otters to use as territorial sign posts, and substrate is available for fish (spawning/hiding places). Sustaining populations of fish will provide a valuable food source for otters; and
6. Steps to enhance fisheries (loosen bed gravels and if channel bed is composed of suitable material, excavate pools and create riffles) – This will ensure that fisheries habitat, fish populations and food availability for otters are improved.

7.3 Specific Extra Mitigation Measures Identified

It is important that any otter holts identified during survey work are dealt with appropriately, to stay within the obligations of relevant legislation (as described in preceding sections). Where a holt is identified by a suitably trained ground staff member, work should not commence until NPWS have been consulted for advice and on the requirement for a licence to proceed.

7.4 Opportunities for Enhancement or Compensatory Measures

This section deals with measures, which may be undertaken, where possible within the remit of the OPW, as part of a habitat enhancement scheme, to increase the value of the drainage network for biodiversity and specifically for otters. For the creation of dry culverts, bolt on ledges, solid ledges and otter fencing, further information is detailed in the Design Manual for Roads and Bridges (DMRB) as described in section 7.1. This work is particularly relevant to road bridges and may not be so relevant to 'accommodation' or 'field' bridges.

7.4.1 Create bays, backwaters and ponds

These will expand opportunities for wildlife within the river corridor. Their slow flowing and still waters are complementary habitats to the main river and provide important refuges for animals in times of flood.

7.4.2 Plant bankside trees and scrub

These are an important feature and they provide shelter and holt sites for otters. They also significantly add to the availability of invertebrate prey for fish populations, which in turn will be of benefit to otters.

7.4.3 Create buffer zones and margins

These will protect river banks against erosion, by binding the soil with plant and tree roots, reduce land run-off by increasing infiltration, trap sediment, absorb nutrients, improve fisheries, provide corridors to aid movement of otters and diversify the river corridor.

7.4.4 Create artificial otter holts

These will provide immediate resting sites for otters. They need to be positioned as close to the waters edge as possible and where otters can climb the bank. Artificial holts can be positioned in areas where maintenance activities are infrequent or do not occur. Such holts may attract otters away from areas where works are ongoing. In such cases, NPWS may suggest a particular design.

7.4.5 Create dry culverts

These are normally places alongside and slightly higher than existing wet culvert, and located on the side of water course most likely to be used by a travelling otter. They provide a safe passage and connectivity between suitable habitats.

It is very important to consider these opportunities for enhancement and compensatory measures. Because, if water level conditions are unsuitable for otters under small bridges or culverts, they will be blocked from passing along the river corridor and will be forced up onto a road, where mortality from traffic is a significant threat (an average of 60% of recorded otter deaths in the UK are road casualties) (DRMB 2001).

Furthermore we would suggest that a survey of culvert designs within otter SACs should be undertaken. Where problems are identified, a forward plan of works (over several years) can be made and 'problem' culverts replaced or adapted to become otter friendly.

7.4.6 Create bolt on ledges

Where road bridges and large culverts have no dry passage (e.g. where abutments stand in the water flow) the most useful mitigation is likely to be a bolt-on ledge. Bolt on ledges should be installed above normal flood levels. It is important to ensure that ledges make direct contact with river/stream banks, both up and downstream of the bridge. They can be achieved either by

continuing the ledge along the length of any wing-walls, or by creating angled ramps that meet the river bank. This type of enhancement may be suitable and most cost-effective when included in the design of bridge maintenance and where relevant, can be agreed during consultation with the Local Authority that has responsibility for the bridge.

The bolt on ledge should provide otters with a dry walkway of between 300mm and 450mm wide, constructed from 4.5mm Durbar patterned galvanised plate.

7.4.7 Create solid ledges

At some sites, considerations of responsibility, cost, aesthetics or practicality might indicate the use of a solid ledge; this is most likely where an existing otter-ledge has proved to be sited too low to offer dry passage at spate conditions.

A solid ledge can be created in 3 ways; concrete bagging, shuttering plus new concrete and concrete blocks.

7.4.8 Otter fencing

Otter fencing can be used alongside bridges to guide otters towards safe crossing points or to steer them away from roads etc. Otter fencing should only be used where other mitigation strategies such as dry culverts etc are also planned.

8. CONCLUSION AND SUMMARY

8.1 Level of Significance of the Likely Impact

The level of significance of the likely impacts is presented in Table 4. With reference to Table 4 it is clear that the main impacts addressed in this assessment, can be mitigated against to reduce their significance. Following the successful implementation of mitigation and enhancement, it is predicted that the impact significance will range from a **low significant impact** to a **significant positive impact**.

8.2 Likely Success of Proposed Mitigating and Enhancement Measures

The proposed mitigation measures described in previous sections of this report will provide significant means by which the impacts of drainage maintenance activities can be reduced.

OPW has shown considerable commitment to the environment through the creation of its environmental team and the production of the EDM guidelines. This commitment, coupled with the mitigation and enhancement opportunities provided in this document, is likely to lead to successful management for otters along Ireland's drainage channels.

8.3 Information Relevant to Future Biodiversity and Heritage Impact Assessments

The information provided in this report bears relevance not only to otters, but should be considered as a part of a wider biodiversity issue. Otters are a keystone species which means they provide a significant role in the aquatic ecosystem.

Any future impact assessments should consider not only the species or habitat they address, but also how these features relate to and affect other ecological interests. For example, an important aspect of otter ecology is the species' foraging resource, which relates directly to fisheries interests. Where possible, fisheries improvements should be continued i.e. loosen bed gravels, habitat creation (pools and riffles), importation of suitable substrate (boulders and gravels), and suitably engineered bridges and culverts for fish passage. For further guidance on road crossings and migratory fish, refer to the consultation paper described below (Scottish Executive 2000)⁴. Scotland is a recognised European leader in this area of design guidance.

It is recommended, therefore, that any further otter assessments, and the consequent mitigation measures undertaken are not prepared in isolation but pay due regard to other relevant ecological impact assessments.

⁴ River Crossings and Migratory Fish: Design Guidance – A Consultation Paper – April 2000

Table 4: Potential Impacts, Mitigation and Residual Significance

Description of Feature	Proposed Activity	Characterisation of unmitigated impact on the feature	Mitigation	Residual significance
<p>Direct Habitat Loss</p> <p>Breeding, sheltering and foraging otters.</p>	<p>Clearance of riparian vegetation including scrub vegetation and mature trees and potential removal of holts and lay-up areas.</p>	<p>Certain Negative Impact.</p> <p>Magnitude and Extent – All areas maintained and complete loss of habitat.</p> <p>Duration – Short term disturbance with long term implications for otter behavioural ecology.</p> <p>Reversibility – Temporary and reversible.</p> <p>Frequency – Intermittent.</p>	<p>Training of front-line staff or use specially trained professional consultants to properly survey ahead of scheduled work.</p> <p>Conduct surveys post maintenance activities (site use and recovery period).</p> <p>Adhere, develop and regularly assess EDM work practices.</p> <p>Retain mature trees and in-stream boulders.</p> <p>No use of heavy plant and use smaller work parties where otters are known to be sheltering (informed by survey work)</p> <p>Maintain regular communication with relevant nature conservation organisations, fisheries boards and rangers.</p>	<p>Moderate significant impact</p>

Description of Feature	Proposed Activity	Characterisation of unmitigated impact on the feature	Mitigation	Residual significance
<p>Severance Breeding, sheltering and foraging otters.</p>	<p>Destruction of connectivity between suitable habitats through vegetation clearance. Disturbance to established territory through removal of in-stream boulders etc.</p>	<p>Extremely unlikely Negative Impact. Magnitude and Extent – All areas maintained with loss of connectivity and consequent disturbance to breeding populations and territoriality. Duration – Long term. Reversibility – Temporary and reversible.</p>	<p>Training of front-line staff or use specially trained professional consultants to properly survey ahead of scheduled work. Adhere, develop and regularly assess EDM work practices. Retain mature trees and in-stream boulders. For future design, construction and maintenance of small bridges and culverts refer to the Design Manual for Roads and Bridges (DMRB). Maintain regular communication with relevant nature conservation organisations, fisheries boards and rangers.</p>	<p>Low significant impact</p>

Description of Feature	Proposed Activity	Characterisation of unmitigated impact on the feature	Mitigation	Residual significance
<p>Loss of life Breeding, sheltering and foraging otters.</p>	<p>Clearance of riparian vegetation and consequent removal of holts and lay-up which may be occupied by sheltering otters and/or their cubs.</p>	<p>Probable Negative Impact. Magnitude and Extent – Limited to discreet holts, which may be spread throughout drainage network. Duration – Long term implications for breeding success of meta-population. Reversibility – Irreversible. Frequency – Infrequent.</p>	<p>Training of front-line staff or use specially trained professional consultants to properly survey ahead of scheduled work. Adhere, develop and regularly assess EDM work practices. No use of heavy plant and use smaller work parties. For future design, construction and maintenance of small bridges and culverts refer to the Design Manual for Roads and Bridges (DMRB). Maintain regular communication with relevant nature conservation organisations, fisheries boards and rangers.</p>	<p>Moderate – high significant impact.</p>

Description of Feature	Proposed Activity	Characterisation of unmitigated impact on the feature	Mitigation	Residual significance
<p>Physical disturbance Breeding, sheltering and foraging otters.</p>	<p>Use of heavy plant and work parties with equipment to clear vegetation or access predefined points along the drainage network. Potential impacts from disturbance and vibration.</p>	<p>Probable Negative Impact. Magnitude and Extent – All areas require maintenance where otters are known to reside. Duration – Short term. Reversibility – Reversible. Frequency – Intermittent.</p>	<p>Training of front-line staff or use specially trained professional consultants to properly survey ahead of scheduled work. Adhere, develop and regularly assess EDM work practices. No use of heavy plant and use smaller work parties. Maintain regular communication with relevant nature conservation organisations, fisheries boards and rangers. Retain mature trees and in-stream boulders. Follow EPA guidance in relation to maintaining high water quality.</p>	<p>Low significant impact.</p>

Description of Feature	Proposed Activity	Characterisation of unmitigated impact on the feature	Mitigation	Residual significance
<p>Noise disturbance</p> <p>Breeding, sheltering and foraging otters.</p>	<p>Use of heavy plant and equipment to undertake maintenance activities and deployment of work parties.</p>	<p>Probable Negative Impact.</p> <p>Magnitude and Extent – Limited to discreet holts, which may be spread throughout drainage network.</p> <p>Duration – Short term.</p> <p>Reversibility – Reversible.</p> <p>Frequency – Intermittent.</p>	<p>Training of front-line staff or use specially trained professional consultants to properly survey ahead of scheduled work.</p> <p>Adhere, develop and regularly assess EDM work practices.</p> <p>No use of heavy plant and use smaller work parties.</p> <p>Maintain regular communication with relevant nature conservation organisations, fisheries boards and rangers.</p>	<p>Low significant impact</p>
<p>Habitat creation</p> <p>Breeding, sheltering and foraging otters.</p>	<p>Maintenance of waterways and habitat suitable for sheltering, breeding and foraging otters. The maintenance of drainage channels will increase fisheries interests creating better quality foraging grounds for otters.</p>	<p>Certain Positive Impact.</p> <p>Magnitude and Extent – All areas require maintenance where otters are known to reside.</p> <p>Duration – Long term.</p>	<p>n/a</p>	<p>Significant positive impact.</p>

Appendix A – Maps

Appendix B – Field Surveys

Site 1 - River Moy SAC (00298) - OPW channel (C1/21/1/5/18/3)



Figure 1: OPW Channel (C1/21/1/5/18/3) Looking Upstream

Maintenance activities - Standard channel works by hydraulic excavator (maintenance observed during survey).

Habitat description - The vegetation bordering the channel (adjacent to the survey area) comprises riparian trees, scrub, tall herbs and agricultural/open grassland. These habitats extend to around 10m from the bankside on either side of the watercourse.

The following were identified as being the dominant species comprising the riparian vegetation:

- Sycamore (*Acer pseudoplatanus*);
- Alder (*Alnus glutinosa*); and
- Hawthorn (*Crataegus monogyna*).

Habitat structure - The riparian habitat throughout the survey area was relatively uniform in terms of species composition with the only variable being the gradient of the land on which it grew. The river channel ranged from 2-4m wide and the structure comprised a series of riffles, deep slow flowing pools and glides. The canopy cover was open and mostly limited to the bankside.

Otter disturbance within the survey area was relatively low, however, an otter slide at a point where the species entered and exited the water, and a clearly marked couch was observed. The couch (~400m upstream from the road bridge crossing) is regularly being used by otter. At this particular location fresh otter spraint (<1week) was recorded.

Spraint - Spraint was observed at several points throughout the site. Regular sprainting sites were identified through the presence of fresh spraint laid over older spraint. These sprainting sites were located on the prominent outcrops and rocks. The age of spraint can be estimated through its composition, colour and scent (although weather can alter this). Using these indicators fresh

spraint was recorded at the couch site. It was estimated that fresh spraint was around 2 days old and had possibly been left at dawn of the day before the survey. Older spraint (<1 week) was identified throughout the survey area and on both banks, this indicates that otter are utilising this area of the channel at least once a week. This pattern of one-week-old spraint under freshly laid spraint was observed throughout the survey area. Regular sprainting sites were located adjacent to deep pools and likely fish holding areas. On analysis spraint found at these sites contained a high proportion of vegetation, fish bone and scales.

Tracks - No otter tracks were identified at the site, either on regular sprainting sites or soft substrate at the water edge.

Feeding remains - No feeding remains were identified at the site.

Paths/Slides - Slides located on the banks mark otter exit and entry points to and from the water. Several slides were identified during the site visit. Most of the slides were associated with thick bankside vegetation and regular sprainting sites. Slides can often indicate points at which otters move between watercourses or they may lead to holts further away from the water. Consequently, the land surrounding slides must be searched extensively.

Holts - No signs of active holts were identified along the length of channel surveyed. Holt sites are routinely marked with copious amounts of fresh spraint and such signs were not observed.

Couches/Lay-ups - As discussed a clearly marked couch was identified (~400m upstream from the road bridge crossing). This lay-up site was found under a densely foliated alder tree, with a thick root network running up to the waters edge and sheltered from a boulder/rock wall. During the survey a heron (*Ardea cinerea*) was observed in this particular area. This is a good indicator that fish populations are present, thus suitable feeding grounds for otter.

Site 2 - Lough Carra / Mask SAC (001774) - OPW channel (CM5/10)



Figure 2: OPW Channel (CM5/10) Looking Upstream

Maintenance activities - Weed cutting by boat (post maintenance).

Habitat description - The vegetation bordering the channel (adjacent to the survey area) comprises riparian trees, scrub, tall herbs and agricultural/open grassland. These habitats extend to around 10m from the bankside on either side of the watercourse.

The following were identified as being the dominant species comprising the riparian vegetation:

- Alder (*Alnus glutinosa*);
- Scots pine (*Pinus sylvestris*);
- Crack willow (*Salix fragilis*);
- Hawthorn (*Crataegus monogyna*); and
- Reed canary-grass (*Phalaris arundinacea*).

Habitat structure - The riparian habitat throughout the survey area was relatively uniform in terms of species composition with the only variable being the gradient of the land on which it grew. The river channel ranged from 4-6m wide and the structure comprised a series of deep slow flowing pools and glides. The canopy cover was open and mostly limited to the bankside.

Otter disturbance within the survey area was relatively low, however, an otter slide at a point where the species entered and exited the water, and a heavily marked couch was observed. The couch (directly under the road bridge crossing) is regularly being used by otter. At this particular location fresh otter spraint (<1week) and re-spraint was recorded.

Spraint - A regular sprainting site was observed directly under the road bridge crossing (Grid ref. M20006 73803). Using the indicators previously discussed (composition, colour and scent) fresh spraint was recorded at the couch site. It was estimated that fresh spraint was around 1 day old and had possibly been left at dawn of the survey day. Re-sprainting (<1 week and >1 week) was also identified at the couch site, this indicates that otter are utilising this area of the channel

frequently. This couch/regular sprainting site was located adjacent to a deep pools and likely fish holding areas. On analysis spraint found at these sites contained a high proportion of fish bone and scales.

Tracks - Otter tracks/scratch markings were identified at the couch site.

Feeding remains - No feeding remains were identified at the site.

Paths/Slides - Only 1 slide was identified during the site visit. This slide (as discussed) was associated with the couch site.

Holts - No signs of active holts (marked with copious amounts of fresh spraint) were observed.

Couches/Lay-ups - As discussed a heavily marked couch site was identified. This lay-up site was found directly under the road bridge crossing, with good access to the water and very well sheltered (overhead bridge and large boulders). During the survey trout (*Salmo trutta*) were observed in the large pool adjacent to the couch site. This is indicative of suitable feeding grounds for otter.

Site 3 - Lower River Shannon SAC (002165) – Mulkear River
OPW channel (C1)



Figure 3: OPW Channel (C1) Looking Downstream

Maintenance activities - Extensive channel works by hydraulic excavator (before maintenance).

Habitat description - The vegetation bordering the channel (adjacent to the survey area) comprises riparian trees, scrub, tall herbs and open grassland. These habitats extend to around 10m from the bankside on either side of the watercourse.

The following were identified as being the dominant species comprising the riparian vegetation:

- Ash (*Fraxinus excelsior*);
- Hazel (*Corylus avellana*); and
- Crack willow (*Salix fragilis*).

Habitat structure - The riparian habitat throughout the survey area was relatively uniform in terms of species composition with the only variable being the gradient of the land on which it grew. The river channel ranged from 2.5-5.5m wide and the structure comprised a series of riffle, shallow / deep pools and glides. The canopy cover was open and mostly limited to the bankside.

Otter disturbance within the survey area was relatively low, however, a potential couch and holt (clearly marked) was observed. The holt (~400m downstream from the road bridge crossing) is regularly being used by otter. At this particular location fresh otter spraint (<1week) and re-sprainting was recorded.

Spraint - The regular sprainting site was observed ~400m downstream from the road bridge (Grid ref. IR78581 48952). Using the indicators previously discussed (composition, colour and scent) fresh spraint was recorded at the potential holt site. It was estimated that fresh spraint was around 2 days old and had possibly been left at dawn before the day of survey. On analysis spraint found at these sites contained a high proportion of fish bone and scales.

Tracks - No otter tracks were identified at the site, either on the regular sprainting/holt site or soft substrate at the water edge.

Feeding remains - No feeding remains were identified at the site.

Paths/Slides - No obvious slides were identified during the site visit.

Holts - A potential holt site was observed (as described above). This active site was positioned under a densely foliated ash tree, with a thick root network running up to the waters edge and very well sheltered with vegetation. A prominent rock at the potential holt entrance was clearly marked fresh spraint and signs of re-sprainting was evident.

Couches/Lay-ups - No obvious couches/lay-ups were identified during the site visit.

Site 4 - River Boyne and River Blackwater SAC (002299) – Athboy River
OPW channel (C1/21)



Figure 4: OPW Channel (C1/21) Facing Downstream

Maintenance activities – Standard channel works by hydraulic excavator (post maintenance).

Habitat description - The vegetation bordering the channel (adjacent to the survey area) comprises riparian trees, scrub, tall herbs and arable/open grassland. These habitats extend to around 10m from the bankside on either side of the watercourse.

The following were identified as being the dominant species comprising the riparian vegetation:

- Crack willow (*Salix fragilis*); and
- Hawthorn (*Crataegus monogyna*).

Habitat structure - The riparian habitat throughout the survey area was relatively uniform in terms of species composition with the only variable being the gradient of the land on which it grew. Throughout the southern bankside and sporadically along the northern bankside trees grew right up to the water's edge. The river channel ranged from 2-3m wide and the structure comprised a series of riffle, shallow / deep pools and glides. The canopy cover was open and mostly limited to the southern bankside.

Otter disturbance within the survey area was relatively low, however, a potential couch was observed (~200m downstream from the road bridge crossing). No obvious signs that otter are using the site frequently were observed, other than large broken snail shells (feeding remains).

Spraint - No spraint was identified at the site.

Tracks - No otter tracks were identified at the site, either at the potential couch site or on soft substrate at the water edge. Engineered rabbit tracks/burrows were identified sporadically along the southern bankside.

Feeding remains - Large broken snail shells were identified at the potential couch site.

Paths/Slides - No obvious slides were identified during the site visit.

Holts - No signs of active holts (marked with copious amounts of fresh spraint) were observed.

Couches/Lay-ups - As discussed a potential couch site was identified. This lay-up site was found under a densely foliated willow tree, with a thick root network running up to the waters edge and sheltered from the bankside. During the survey a heron (*Ardea cinerea*) and a kingfisher (*Alcedo atthis*) and good numbers of trout (*Salmo trutta*) were observed in this particular area. This is indicative of suitable feeding grounds for otter.

Appendix C – References

REFERENCES

- Bailey, M. and Rochford J. (2006) - Otter Survey of Ireland 2004/2005. Irish Wildlife Manuals, No. 23. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
- CEC (Council of European Communities) (1992) - Council Directive 92/43/EEC OF 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities, L206/7-50.
- Chanin (2003) - Ecology of the otter. Conserving Natura 2000 Rivers Ecology Series NO. 10, English Nature, Peterborough.
- Chapman, P.J. and Chapman, L.L. (1982) - Otter Survey of Ireland 1980-81. The Vincent Wildlife Trust, London.
- Crawford, A. (2003) - Fourth Otter Survey of England 2000-2002. Environment Agency, Bristol.
- DMRB (2001) - Design manual for roads and bridges (DMRB). Volume 10, Section 4 Environmental Design and Management Nature Conservation. Part 4 ha81/99 Nature conservation advice in relation to otters.
- IEEM (2006) - Guidelines for Ecological Impact Assessment in the United Kingdom. Institute of Ecology and Environmental Management, Winchester.
- Lunnon, R. and Reynolds, J. (1991) - Report on the National Otter Survey of Ireland 1990-91. Unpublished Report to the Wildlife Branch, Office of Public Works, Dublin.
- NPWS (2005) - www.npws.ie.
- OPW (2006) - Screening of Natura 2000 Sites for Impacts of Arterial Drainage Maintenance Operations. Environment Section, Engineering Services, Office of Public Works.
- Scottish Executive (2000) - River Crossings and Migratory Fish: Design Guidance. A Consultation Paper - April 2000.
- Whilde, A. (1993) - Threatened Mammals, Birds, Amphibians and Fish in Ireland - Irish Red Data Book 2: Vertebrates. HMSO, Belfast.