# FURTHER GUIDANCE ON THE ENVIRONMENTAL ASSESSMENT OF PROJECTS

NRA

National Rivers Authority

This manual contains scoping guidance notes for the following development types in Section 4:



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N.B. Area Regional Specialists/Planning Liaison contacts are given in Appendix C.

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Feedback

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From:.................................................................................................................

**Further Guidance on the Environmental Assessment of Projects**

I have the following comments/suggestions for improvement for the manual:

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Please append any additional information.

Signed: ..........................................................................
Position: ..........................................................................

Date: ..... / ..... / .....

## Introduction

This manual has been produced primarily to provide scoping guidance to developers and/or their consultants on the general concerns of the National Rivers Authority (NRA) for a number of specific types of development types and also for several more general development issues. The guidance notes in this manual complement the (less detailed) scoping guidance provided in an associated manual.

The notes presented in Section 4 of this manual, are not intended to replace consultation with specialists from the NRA and/or other organizations, nor are they intended to act as guidance notes to cover all environmental issues. For instance, factors such as the traffic flow implications of a development are not considered (despite their importance), as these are not within the remit of the NRA. The notes are intended to convey issues within the NRA's statutory responsibilities that may commonly arise in connection with certain types of development.

The notes are necessarily of a general advisory nature and they should only be used without prejudice in considering individual development proposals. More detailed and possibly alternative recommendations will arise in discussions or negotiations with the NRA on specific proposals.

In addition to scoping guidance notes, this manual includes general information on how the NRA interacts with the statutory EA process, on general procedures for environmental assessment and appraisal within the NRA, review criteria and a list of EA contacts.

It is intended that this manual will serve several purposes and audiences. The manual will act as a useful source of reference and guidance for NRA staff. The individual guidance notes can usefully be supplied to developers or their consultants as discussions over a scheme develop. It is envisaged that they would be supplied at an intermediate stage. For example, the less detailed scoping guidance might be supplied in response to an initial inquiry, at a stage when there are firmer indications that planning permission is to be sought from the relevant authorities, or subsequently as a basis for detailed negotiations at a later stage, should they arise. The optimal timing to issue these notes will be case specific and at the discretion of the planning liaison or other officer dealing with the project.

The manual is intended to provide guidance relevant to current NRA responsibilities. With the formation of the Environment Agency, the manual will inadequately reflect a broader range of responsibilities and this will need to be taken into account.

## Section 1 Introduction to Environmental Assessment in the NRA

Environmental impact assessment or environmental assessment (EA) was formally introduced into the UK by the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199), which implemented much of the EC Directive on the assessment of the environmental effects of certain public and private projects on the environment (85/337/EEC).

General guidance on environmental assessment procedures for projects covered by planning law has been provided by the Department of the Environment/Welsh Office (DoE/WO) publication *Environmental assessment: a guide to the procedures*, first published in 1989, but since updated. The guidance indicates which development should be subject to statutory EA; the process of identifying whether a project requires EA is generally termed "screening". The guidance also indicates what broad issues should be covered in an EA; defining the particular issues relating to a development proposal and the studies required to assess potential impacts is known as "scoping".

The DoE is producing guidance on best practice in the production of Environmental Statements (ESs); ESs being the printed output from the process of EA.

For the purposes of this manual, Environmental Assessment in the NRA has been interpreted in a broader sense than that of the legislation and takes on a variety of forms, depending on the nature of the development proposal. (Development itself is taken to have a broad meaning from abstraction/discharge proposals to major schemes such as airports).

The NRA comments on a variety of development proposals from external sources. The form of information received, upon which the NRA comment, is generally one of three types:

- a planning application with Environmental Statement (ES);
- planning applications without an ES, but possibly with some environmental information supporting; and
- applications for consents or licences, often associated with development proposals.

In addition, there may be presubmission inquiries relating to each of the above from developers and/or local planning authorities (LPAs).

In effect, there is a continuum of the scale and/or environmental significance of applications from relatively minor consent or licence applications to large-scale development proposals. Although the term "environmental assessment" (EA) in its strictest sense may be restricted to larger scale development, the principles apply to smaller scale development for which the term "environmental appraisal" (ea) is generally applied. (The term environmental appraisal may also be used to describe the assessment of the environmental implications of strategic plans, e.g. regional development plans). No distinction between the two terms is made, except in consideration of the statutory need for formal environmental assessment (formal EA) under the terms of relevant legislation, such as the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199).

The NRA has a variety of environmental responsibilities as set out in the Water Resources Act 1991 (see Section 4). As such, there may be issues of relevance to the NRA in the majority of development proposals. Early involvement of the NRA is essential to avoid confrontation at an advanced stage of planning. For example, planning permission may be granted for a proposed development, with the NRA first becoming aware of the proposal when applications for discharge or other consents are subsequently sought. The NRA may wish to refuse such applications for discharges, thus compromising the development, or may be under economic pressure to give consent, possibly compromising the environment. Clearly, such situations are avoidable if developers and LPAs make early contact with the NRA. Early notification of proposed development will enable the identification of sensitive areas or issues before detailed planning occurs and will permit the NRA to have an input into the scoping of environmental studies conducted in connection with the proposed development.

Contact with the NRA at an early stage is recommended for a wider variety of development types than those for which the NRA is a statutory consultee. Under the Town and Country Planning (General Development Procedure) Order 1995 (SI 1995 No. 419; formerly the General Development Order) the LPA is obliged to consult with the NRA prior to granting planning permission for the following development types:

- development involving or including mining operations;
- development involving the carrying out of works or operations in the bed of or on the banks of a river or stream;
- development for the purposes of refining or storing mineral oils and their derivatives;
- development involving the use of land for the deposit of refuse or waste;
- development involving sewage, slurry or sludge treatment or disposal;
- development relating to the use of land as a cemetery; and
- development for the purposes of fish farming.

In practice, LPAs are generally requested by the NRA to consult on a wider range of development types by means of Town and Country Planning Liaison documents issued by the NRA. Regions vary, but typically these development types include:

- development which departs significantly from published Development Plans;
- development within or adjacent to any watercourse on floodplains including coastal plains and tidal lengths of rivers, washlands and in areas where there may be drainage problems;
- development on, under, or adjacent to, or protected by any flood bank, sea defence or other flood control structure;
- development which may affect an aquatic/wetland site of conservation interest;
- development of contaminated land;
- development involving the disposal of sewage (other than to a public sewer) including the use of septic tanks, cesspits, sewage treatment plants and private sewers;
- development which could affect groundwater protection zones;
- development which could exacerbate existing sewerage or sewage disposal problems;
- petrol filling stations or other storage facilities for petroleum products, chemicals etc., including fertilizers and pesticides (above or below ground);
- timber treatment plants;
- intensive livestock and poultry units;
- kennels, catteries, stables etc.;

- mineral workings and exploratory works including restoration;
- waste disposal operations (including landfill, waste transfer stations, incinerators, scrap yards, bailing and recycling plants and solvent recovery plants);
- burial grounds;
- development of water based recreation facilities;
- vehicle parks and plant hire depots;
- major residential, industrial and commercial developments;
- fish farming activities including fish stocking or relocation of fish or works which will restrict the movement of fish;
- camping and caravan sites;
- golf courses;
- swimming pools;
- water reservoirs and conservation lakes;
- development requiring an environmental assessment; and
- highways, railways, power stations, airports and tunnels and any associated facilities.

## Section 2 Environmental Assessment Procedures in the NRA

The NRA will seek to assess the environmental implications of all inquiries relating to proposed development, planning applications brought to its attention and applications for NRA licences/consents. The nature of such assessments and the procedures involved will vary depending on the likely significance of impacts and local staffing arrangements. In general, planning applications will be received by planning liaison staff, whereas applications for consents will be received by relevant functional staff. The procedures are set out below in more detail. In general, it is important that documentation is kept on all correspondence in easily accessible information systems with suitable coding/cross referencing systems.

**Inquiries** - Inquiries prior to submission of planning and/or licence consent applications will generally be dealt with by a variety of staff, but in general should be dealt with by Area planning liaison staff in the first instance. Planning liaison may refer such inquiries to relevant functional staff. Where appropriate, planning liaison staff should send copies of relevant scoping guidance; the level of guidance issued will be at the discretion of the NRA staff member and depend on the nature of the scheme and how advanced the development proposal is.

**Planning applications** - Planning applications are dealt with by planning liaison staff, who disseminate the application (in its entirety) to relevant functional staff for comment. Comments should be returned to the planning liaison[1] staff member assigned to the project within the time period specified by that officer. In turn, a coordinated response should then be made, including requests for further information, if appropriate. Such recommendations should be clear and, if appropriate, strongly worded; LPAs may be reluctant to adopt "woolly" comments. It may be relevant to issue scoping guidance to put requests for further environmental information into context.

Note that some NRA Regions rely on LPAs to assess which planning applications the NRA should be asked to comment upon; the LPAs can use the NRA-produced Town and Country Planning document for guidance. Other NRA Regions operate a visitor system, whereby NRA staff visit LPA offices to review lists of planning applications received to assess which should be referred to the NRA.

**Environmental Statements** - If a planning application is accompanied by an environmental statement (ES), this too should be disseminated by planning liaison along with the planning application. Where it is known that an ES is to be carried out, eg at the direction of the LPA, the NRA should issue relevant scoping information. The quality of ESs received should be assessed using one or more of a variety of tools. In instances where scoping guidance has been provided the guidance itself may be used as a checklist to ensure that issues have been addressed. More generally, however, the review criteria presented in Appendix B should be applied. These tools may also be applied (at the discretion of the NRA officer concerned) to other environmental information supplied in connection with development proposals not requiring formal EA and production of an ES.

[1] The titles of staff dealing with planning liaison will vary between NRA Regions.

Where it is felt that feedback on the quality of an ES/environmental information is appropriate, a form of notification may be issued.

**Applications for consents/licences** - Applications for consents/licences may be received either by planning liaison staff or directly by relevant functional staff. For example, applications for land drainage consents are generally dealt with by Flood Defence or Development Control staff (titles may vary). Where applications are made in connection with development proposals, cross reference should be made with planning liaison staff as to the previous correspondence over the planned development.

In instances where the guidance notes presented in Section 3 are copied to outside bodies (e.g. developers and/or their consultants), it is recommended that a covering letter of the form presented in Appendix C is attached. Note that there should initially be a presumption against dissemination of the notes to local authorities; such liaison may preferably be carried out through each Regional Technical Planning Manager. Also, note that in many instances it may be appropriate to send more than one guidance note. For instance, the note on general construction may be applicable to most developments involving the erection of buildings. Other information such as Pollution Prevention Guidance should also be issued and Appendix D provides advice to NRA staff on material that may be useful for both internal and external consumption in considering specific project types. Note that some of the documents referred to may be confidential.

Finally, the notes largely address direct impacts. However, indirect impacts arising from development will need to be considered in an EA.

## Section 3 Guidance Notes

N.B. A separate page numbering system has been used for the following guidance notes in order that they can be issued as stand alone documents. The page numbers of the notes are prefixed by the numerical order appearing on the inside front cover.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF GENERIC IMPACTS OF CONSTRUCTION WORK

## 1. Introduction

This guidance note seeks to identify the potential impacts of general construction activity upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the Environmental Assessment (EA) of general construction schemes. Notes at two levels of detail have also been produced for various specific development types (see Appendix 1), including infrastructure works, such as roads and pipelines, and the redevelopment of contaminated land. This guidance note should be used to accompany such notes, where appropriate, as for most development types there will be general construction issues which are not considered in such depth in the specific notes. In each case the guidance notes concentrate on issues specifically of concern to the NRA.

The NRA has an interest in construction activities due to their potential impacts on water quality, water resources, flood defence, fisheries, conservation, recreation and navigation. In most instances, the NRA will require, as a minimum, supporting environmental information when considering development proposals before issuing various consents and/or licences. For certain more significant development projects a formal environmental assessment is required by law. The responsibility for obtaining information and/or an environmental assessment lies with the developer. There are distinct advantages for developers in contacting the NRA (see Appendix 2 for contacts) and conducting environmental studies well in advance of any proposed development. This should enable environmental constraints to be identified and avoided, where possible, and also enable the design of appropriate mitigation into the planned development. The developer should be able to demonstrate reasonable consideration of alternatives for the proposed scheme. There should also be the consideration of strategic issues such as the availability of water resources to meet the particular development's needs. Such issues may be on a catchment, regional or national level.

## 2. Development control

The local planning authority will provide advice on the development controls applicable to a particular development proposal and the need for environmental assessment. Typically, development will be covered by the Town and Country Planning framework. The NRA are statutory consultees for a variety of development types as set out in the (recently consolidated) General Development Order, but in practice are consulted on all types of development which affect the water environment or associated land.

## 3. Environmental Assessment

Certain development types require formal environmental assessment under SI 1988 No 1199 The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 and related regulations. These regulations together implement the European Community Directive on the assessment of the effects of certain public and private projects on the environment

(85/337/EEC). Guidance on the regulations may be found in *Environmental Assessment - A guide to the procedures* (DoE/WO 1989) and, more formally, in DoE Circular 15/88 (WO 23/88). Guidance on the content of Environmental Statements (ESs) may be found in the former. The DoE is currently preparing more detailed guidance on the general preparation of ESs.

Involvement of the NRA and other relevant bodies at an early stage will identify specific areas of concern (scoping) to be addressed in the environmental assessment. Guidance notes are available from the NRA for the scoping of specific development types (see Appendix 1). Detailed guidance may also be available on specific aspects of development, such as NRA Pollution Prevention Guidelines on the design of above ground oil storage tanks. (A full list of Pollution Prevention Guidelines is given as Appendix 3). The NRA has also published its *Policy and practice for the protection of groundwater* (NRA 1992a) and a variety of other reports (see Further guidance and references) that may be relevant for particular development types.

Other guidance that may be relevant includes that produced by the Construction Industry Research and Information Association (CIRIA), which includes *Environmental Assessment* (CIRIA 1994). The latter recommends the consideration of a voluntary environmental assessment, where environmental assessment is not formally required.

## 4. NRA authorizations

Licences or consents may be required from the NRA to carry out certain activities. The NRA will be willing to discuss its requirements. Applications are subject to advertising; they may also be refused by the NRA. Appeals may be made against refusal. If the NRA rejects an application for consent, then other outstanding applications will not be processed until the issues surrounding the rejection are resolved.

**Land drainage consents** are required for any works on the bed and banks of a 'main river' watercourse or construction of any structure likely to impede the flow. Local authorities and Internal Drainage Boards have responsibility for certain smaller watercourses. Works affecting sea and tidal defences will also require consent under Regional Byelaws.

**Discharge consents** may be required for discharges to inland and coastal surface waters. Discharges to groundwaters, e.g. via soakaways, may also require consents. (Note that under the Environmental Protection Act 1990 the consenting authority for discharges from certain processes is Her Majesty's Inspectorate of Pollution).

**Abstraction licences** may be required for abstractions of groundwater and surface water (including test pumping and dewatering operations).

**Impounding licence** may also be required where impoundment takes place.

A **navigation consent** or licence to undertake works in, on or over a navigable river where the NRA is the navigation authority.

Breaches of licence or consent conditions or pollution of surface and groundwaters may result in criminal proceedings.

In addition to the above, NRA approval will be required for the application of herbicides in or near watercourses and for introductions of fish, e.g. for angling purposes. Local NRA byelaws may also exist which may need to be taken into account.

## 5. Major/Potential impacts

In general, the NRA will be concerned about impacts upon water quality, water resources, flood defence, hydrology, fisheries, aquatic and bankside wildlife, navigation, recreation and amenity, landscape, archaeology, and geomorphology. As a general rule, it will be necessary to demonstrate that water quality is not adversely affected. Also, river corridors may represent both important wildlife habitat and landscape features; the integrity of these should be maintained.

**Site investigation** such as the drilling of boreholes may have a variety of impacts including the disturbance of contaminated land with resultant pollution of groundwater or surface waters.

**Land take** may result in the general destruction of habitats and displacement or loss of species. Land take may also lead to a loss of access for recreation.

**Stripping of topsoil and loss of surface cover** may result in increased soil erosion with an associated increased sediment load in rivers. Flood risk may increase through sedimentation within rivers and from direct erosion of defences. High suspended solid loadings reduce water quality with direct impacts on wildlife, the aesthetic appearance of a watercourse and recreation quality (e.g. fishing). Sedimentation will in turn alter substrate quality for aquatic insects and plants. Fish and their spawning areas may be particularly damaged by siltation, resulting in reduced survival, particularly of their eggs. The ground surface may demonstrate altered infiltration, with associated impacts on groundwater resources. Increased runoff from the land surface will result in an altered hydrological response to rainfall, with possible adverse consequences for flood defence, fisheries, other aquatic wildlife, and water resources. (There may also be positive effects from increased river flow in some circumstances, e.g. in low/no flow watercourses.) Removal of attenuating surface layers may increase the risk of aquifer (groundwater) contamination. Archaeological sites may also be damaged. The aesthetic appearance of earthworks and general construction may be poor and the landscape affected on a temporary or permanent basis.

**Soil handling and disposal** may lead to high levels of suspended material in runoff, with resultant poor water quality and the smothering of important habitats. Imported or excavated materials may also be vulnerable to leaching, such that acidic, organic or toxic runoff may contaminate groundwater or surface waters. In addition, imported material may contain seeds or root fragments of invasive or otherwise unsuitable plants. (It is an offence under the Wildlife and Countryside Act 1981 to spread certain species, e.g. Japanese knotweed).

**Soil mounds and embankments** may damage wildlife and interrupt existing drainage patterns. Storage of soil in the flood plain will reduce flood storage.

**Compaction** of river banks by heavy machinery may lead to a loss in bank stability, destruction of soil structure, natural drainage and destruction of bankside vegetation.

**Tree removal** from banksides may result in the destruction of wildlife habitat, including bird and bat roosting sites and otter holts, and also a reduction of bank stability with subsequent erosion. Fisheries may be affected by losses of food and cover provided by trees and their roots. (Damage to the habitat of certain protected species, such as otters and bats, is an offence under the Wildlife and Countryside Act 1981). Increased water temperature may result from a loss of shading, with potential ecological consequences. Algal and other plant growth may be stimulated by increased light leading to further ecological changes and possible water quality and flood defence problems. Tree loss may also result in a loss of landscape/amenity value.

**Bad practice** or a lack of care in a variety of construction activities may cause pollution of watercourses and groundwater. Examples include: the improper disposal of chemicals and containers; poor oil handling procedures and unprotected storage; the pouring of cement near watercourses; careless grouting of bridges; the direct discharge of water from dewatering operations; disposal of poorly treated site sewage; and work near, or on, operational sewers. Pollution may affect aquatic wildlife by affecting the oxygen regime of the receiving water, by direct toxicity, or by limiting the amount of natural food available. Such effects can result in the loss or displacement of fish. Downstream water abstractions may be jeopardized as may other uses such as angling. The aesthetic value of the watercourse may be reduced. In addition, pollution of watercourses may constitute a health hazard for recreational users, particularly those engaged in contact watersports. Direct blockage of watercourses may arise from various debris and lead to flooding.

**Noise and intrusion** may cause disturbance to fauna (e.g. breeding birds) and the outward migration of sensitive species. In addition, there may be degradation of enjoyment and quality of experience of people on or near water close to the site.

**Dust** may add to suspended solid loads in watercourses and smother plants.

**In-channel work** may cause direct destruction, damage and disturbance to wildlife, present a barrier to navigation and fish, result in the loss of (recreational) access to the river, and lead to changes in the river substrate and channel geomorphology. These changes may be remote from the development site and have knock-on effects, e.g. bank erosion and bed draw down may affect building foundations, tree stability etc. Sediment resuspension may lead to reduced water quality and siltation downstream. In addition, in-channel work may increase flood risk. Bunding (and dewatering) of working areas may trap fish.

**Dewatering operations** may reduce surrounding water table levels, affecting existing building foundations and the ecology of adjacent areas (e.g. wetlands and ponds) and spring-fed systems. Dewatering may enhance hydraulic continuity with underlying groundwater which is particularly undesirable near public supply boreholes. Dewatering may also derogate the rights of existing users to abstract water. The criteria necessary to support existing recreational use may be affected. River flow changes may affect the dilution of effluent discharges. Dewatering from within working areas can result in silt and suspended solids being pumped from an excavation to a watercourse, causing pollution. In addition, dewatering operations may also draw in water from surrounding contaminated land.

**Disturbance of contaminated land** (e.g. from excavations, piling and borehole construction) may cause pollution of groundwater and surface waters, although removal of contaminated land or sediments may result in long-term water quality improvements. The issue of contaminated land is covered in more detail by another guidance note (see also NRA 1994a).

**Diversion of streams** will result in the loss of a section of river with its associated and long-established habitats, flora and fauna. In general, the newly created section will initially be ecologically poor and lack habitat features. It may also be unstable, leading to bank and bed erosion and flood defence problems. Diversions may also affect existing rights of abstraction and alter dilution patterns of effluent discharges.

**Culverting** will result in shading and the loss of natural bankside and substrate along the affected section of river. This will lead to temperature changes, a loss of plants and faunal changes. The culvert may be a significant break in habitat continuity and act as a barrier to the migration of fish, birds, mammals and other groups. Culverts will increase flood risk if they are of inadequate cross section and/or prone to blocking by debris. The water quality within longer culverts may deteriorate. Dissolved oxygen in particular may decrease due to reduced wind/air contact with the water surface, lack of plant photosynthesis and decomposition of organic matter. In some circumstances culverts may enhance public safety and amenity.

**Impervious surfaces** such as buildings, roads, car parks etc. will lead to increased runoff, affecting the hydrological response of the area, with subsequent effects on flood risk, bed and bank stability, and flora and flora. Low flows may occur between rainfall events, and storm runoff may be of poor water quality. Water resources and users (including wildlife) may be impacted downstream. Reduced infiltration may reduce groundwater resources.

**Buildings and other structures** may result in the loss of flood plain capacity, with corresponding flood risk implications. Buildings and other structures may intrude into the local landscape and alter wind flow patterns affecting recreational use (e.g. sailing, wind surfing). The foundations of buildings, roads etc. may also interfere with groundwater flows. Pilings may also create pollution pathways to sensitive aquifers. Certain building materials may cause water quality problems, e.g. runoff from some breeze blocks may be alkaline.

**Access roads** may lead to impacts from land take, soil compaction, noise, intrusion, dust, impervious surfaces and temporary loss of flood storage or diversion of flood flows.

**Compounds, car parks** and other areas associated with the site of construction may extend construction impacts. Together these may restrict public access to the area.
**Pesticides and fertilizers**, where stored and/or used, may cause pollution of groundwater and surface waters and destruction of established wildlife.

## 6. Mitigation measures

The **location,** **size** and **type** of development will be key factors in determining impact significance. Construction activities including access routes should avoid sensitive areas, such as:

- flood risk areas, e.g. flood plains and low lying coastal areas;
- rivers and river corridors of high ecological, landscape or amenity value;
- rivers supporting valuable fisheries, e.g. self-sustaining salmon stocks;
- wetlands and marshes;
- coastal foreshore and saltings;
- areas of conservation importance, e.g. Sites of Special Scientific Interest (SSSIs);
- vulnerable aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992a);
- close proximity to important uses of water, e.g. public water intakes, groundwater abstractions and popular recreational areas; and
- upland areas of catchments with particular sensitivities.

The **timing** of activities should be such that sensitive periods, such as bird nesting and fish spawning seasons, are avoided. Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant period, e.g. the installation of mesh to prevent house martins and swallows nesting in the eaves of a building to be demolished. Licences from English Nature (EN) or the Countryside Council for Wales (CCW) may be required to deal with protected species (e.g. bats, great crested newts, badgers, otters). Disturbance to public recreation may be greater in the summer, but wet ground conditions leading to increased soil compaction are more prevalent in the winter.

In general, the advice of relevant organizations, e.g. NRA, EN/CCW, English Heritage etc. should be sought in connection with development proposals.

Developers and their contractors should follow **building regulations, codes of good practice** and NRA Pollution Prevention Guidelines etc., where these are applicable. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor should be employed to ensure the protection and enhancement of the environment. The environment should not be compromised by taking short cuts to avoid time or other penalty clauses for contract completion. Every effort should be made to prevent pollution and other potential impacts.

Both permanent and temporary **land take** should be minimized and original habitat features maintained or enhanced.

The **storage and handling of soil** should be such that the area affected is minimized but the soil structure is maintained as much as possible (i.e. avoid mixing topsoil with underlying material). Stored and other exposed soil or spoil should be covered to minimize silt runoff. Imported material should be avoided where this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value.

Opportunities to **create wetland or other habitats** should be considered.

**Compaction of soils** by heavy machinery should be minimized, particularly in sensitive sites, with the use of boards, matting and other temporary supporting structures and tracked or soft-tyred vehicles. Where unavoidable compaction occurs, de-compaction measures should be undertaken on completion of works.

**Trees and other wildlife habitats** should be retained. Opportunities should be sought to replant trees and create new habitats, as appropriate. Woodland planting should conform to relevant guidelines, e.g. Forestry Bulletin 112 *Creating New Native Woodlands*. Habitat improvements and other mitigation works may be considered at locations remote from the construction area. For instance, a fish pass could be installed to generally improve the access of fish to a watercourse.

**Sites of archaeological and other interest** should be preserved *in situ*, where feasible, with the provision of facilities for visitors. However, relocation may need to be considered.

**Chemicals, fuel and oil** should be suitably stored in areas away from watercourses and drains with adequate bunding should spillage, leakage, pipe, valve or tank failure occur. Bunds around tanks are obligatory. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper-proof valves, adequate fencing and security. Where appropriate, pollution prevention equipment should be kept on-site and employed in the case of spillage, e.g. emergency drain covers, absorbent granules etc. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects.

**Sewerage and waste disposal** arrangements should be adequately considered. It may be necessary to discharge sewage and canteen wastes to an on-site temporary storage facility prior to offsite treatment and disposal. The construction contractor should fulfill all the obligations imposed under the Environmental Protection Act 1990 Section 34 (Duty of Care) on producers of waste and ensure that waste generated from construction is managed according to good waste management practice incorporating good housekeeping. Relevant pollution prevention guidance as supplied by the NRA should be followed wherever possible (see Appendix 3).

**Noise and intrusion** should be minimized and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites. Pumps/machinery should be suppressed or housed, if disturbance is likely to occur, to reduce noise impact.
**Dust** may be dampened down to reduce aerial transmission, but should not be washed into drains etc. (Abstraction of water for dust suppression may require an abstraction licence). Vehicle (wheel) wash facilities should be adequately constructed with containment of the effluent for proper treatment and disposal.

**In-channel work** should only be carried out if there is no practical alternative (e.g. thrust boring). Work should avoid disruption to relevant seasonal activities, i.e. navigation, fish spawning. Interruption to recreational access and navigation should be minimized, although public safety should not be compromised. Methods of working should be used that minimize the extent of disturbance to the banks and bed of the river. Where channels lack natural features (e.g. man-made trapezoidal channels) opportunities to improve channel form for conservation purposes should be sought in consultation with the NRA. Bunding or booms should be utilized where there is a risk of oil or other pollution. Trapped fish should be rescued from bunded/dewatered working areas.

**Contaminated land**. Government guidance encourages the development of contaminated land; remedial action will be required where such development is likely to lead to pollution of groundwater and surface waters (see separate guidance on the redevelopment of contaminated land). In general, opportunities should be sought to provide permanent remedies to contaminated sites; disturbance of contaminated land or sediments should be avoided unless complete removal is to occur (with disposal of spoil to registered sites). Where disturbance of contaminated material is unavoidable, care should be taken to avoid pollution of watercourses and groundwater. The use of protective linings may be required. Impervious surfaces may contain the pollution, where the main risk of pollution is from rainwater leaching.

**Groundwater drawdown** may be prevented by minimizing the entry of water into construction works (e.g. by using diaphragm walls, well pointing, compressed air).

**Diversion of streams** should generally be avoided, due to the major effects on rivers and river corridors. Where diversion is unavoidable, efforts should be made to simulate the river geomorphology of the affected reach (e.g. similar gradient and number of pools, riffles and meanders). The new reach should be designed to maximize conservation opportunities, i.e. straight concrete-lined, trapezoidal channels should be avoided. Fish should be rescued from the stretch of river to be diverted. Planting of the new channel should occur with soil and plant material from the redundant stretch. Where possible, elements of the redundant stretch should be retained as ponds or wetlands. (NRA Conservation staff will be happy to advise).

Where **culverting** is unavoidable, the culvert should normally be over-wide and the invert should be set below normal bed level to enable some bed features to reform. Headroom should be maximized for light entry and to permit the passage of birds and mammals. A ledge or berm should be installed above normal water levels to aid the passage of the latter. Bat roosting and bird nesting structures should be considered in larger culverts. Adequate headroom and/or screening will also reduce flood risks. (Guidance is available from the NRA on the design of trash screens (NRA 1993a)). Stream velocities should not increase within the culvert so as to preclude the upstream migration of fish. The culvert should be designed to allow the passage of highest predicted flood flows. Agreements will be required on the future maintenance of the culvert.

The extent of **impervious surfaces** may be reduced by the use of permeable membranes, floating roads, pervious gabions, provided that there is not a high risk of contamination from throughflow. The discharge of runoff may be regulated by passage through balancing ponds/retention basins. These may also act as sediment traps and as a buffer against poor water quality from storm runoff. They may also provide useful aquatic and wetland habitats. Other drainage facilities such as oil separators (interceptors) should be considered if oil is a likely pollutant. Responsibilities for the maintenance and operation of such devices should be agreed in advance. Isolation points designed into the drainage system may be useful to prevent pollution of watercourses where there are high risks of spillage. CIRIA have produced various relevant guidance with respect to site and road drainage, e.g. CIRIA (1992) and Luker and Montague (1994).

If the construction of **buildings** in the flood plain is unavoidable, mitigating measures will be required so as not to increase flood risks to existing property. The buildings themselves will need flood protection which could take the form of construction to a specified floor level, site landscaping etc. The use of local materials may minimize landscape intrusion.

Buildings should be designed or located so as to avoid detrimental wind patterns to waters with relevant recreational use.

**Access roads** should be designed to take flood risk into account. The use of river fords should be considered to recreate riffles in degraded rivers/streams. Measures should be taken to reduce compaction and control drainage (see above).

**Compounds, car parks** and other areas associated with the site of construction should be carefully located to minimize any added impacts. The area should be fenced to provide security and to contain the area of impact. Surface drainage from these areas and associated facilities (e.g. wheel washes) should be considered with respect to pollution risk and treatment requirements. Temporary diversion of informal footpath access which cross the compound will minimize inconvenience to the public. Compounds and other temporary working areas should be reinstated following discussions with the NRA and other interested parties.

**Pesticides and fertilizers** should be stored and used in accordance with legislation and codes of practice. They should be used only when necessary. Only approved pesticides should be used in or near watercourses, with prior permission of the NRA. Relevant guidelines should be followed, e.g. NRA (1995). (Guidelines from the Ministry of Agriculture, Fisheries and Food are currently being revised).

Stands of invasive non-native plant species, such as Japanese knotweed and giant hogweed, should be controlled following NRA guidance (e.g. NRA 1994b) should they arise from the development (e.g. from imported soil).

## 7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies (for which a charge may be made). Surveys should be conducted at relevant times of year using methods recommended by relevant organizations, e.g. NRA, EN/CCW. Surveys may be required over several years to establish certain variable baseline conditions, e.g. fisheries, aquatic biology. The findings should highlight particularly sensitive sites, physical features, habitats or species.

In general, the NRA may require information on the following (from surveys or otherwise):

- flora and fauna (e.g. river corridor survey);
- fisheries;
- aquatic biology;
- water quality;
- water resources;
- hydrology and hydrogeology;
- hydraulics, bed profile and cross-sections;
- landscape/amenity;
- recreation;
- river geomorphology;
- archaeology

The actual type and nature of surveys and data required will be case specific should be relevant to assessing impacts. NRA guidance is available on recommended survey methodologies for river corridor surveys (NRA 1992b) and for landscape assessments (NRA 1993b). The NRA will be able to provide relevant any data it holds (although there may be an administrative charge)

## 8. Monitoring and audit

A monitoring programme relevant to assessing predicted impacts and the success of mitigation works is recommended and may be required for certain NRA consents/licences.

Audits of site management practices during construction may be desirable to ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment.

## 9. General guidance and references

Some guidance on the location of sites where development is likely to be discouraged may be found in local authority structure and development plans and also in NRA catchment management plans. Government-issued Planning Policy Guidance (PPG) may also indicate the framework within which Local Planning Authorities (LPAs) operate. Of particular relevance to NRA concerns is PPG23 *Planning and Pollution Control* published by the DoE in 1994. There may also be local Consultation Guides as defined by discussions between staff from NRA Regions/Areas and LPAs.

Appendix 3 gives a list of NRA Pollution Prevention Guidelines. Note that, like DoE Planning Policy Guidance notes, these may also be referred to as PPGs.

English Nature (1994a) provide guidance on various types of habitat creation in connection with road schemes, although the principles are applicable for other development types. More general guidance on the inclusion of nature conservation in EA is also available (English Nature 1994b).

In addition, PPG9 *Nature Conservation,* published by the DoE in 1995, provides planning guidance.

The Institute of Environmental Assessment have produced guidelines for landscape and visual impact assessment (IEA 1993a) and baseline ecological assessment (IEA 1993b).

Guidance on the environmental assessment of buildings is given by Wozniak (1994) and publications by the Building Research Establishment (BRE). There now exists the Building Research Establishment· has produced Environmental Assessment Methods (BREEAM) for various categories of buildings (i.e. superstores and supermarkets, new homes, new offices, existing offices, and new industrial units; BRE 1991a, 1991b, 1993a, 1993b, 1993c).

Building Research Establishment (1991a) *An environmental assessment for new superstoreand supermarket designs.* Building Research Establishment, Watford.

Building Research Establishment (1991b) *An environmental assessment for new homes.* Building Research Establishment, Watford.

Building Research Establishment (1993a) *An environmental assessment for new office designs.* Building Research Establishment, Watford.

Building Research Establishment (1993b) *An environmental assessment for existing office buildings.* Building Research Establishment, Watford.

Building Research Establishment (1993c) *An environmental assessment for new industrial, warehousing and non-food retail units.* Building Research Establishment, Watford.

Construction Industry Research and Information Association (1992) *Scope for the control of urban runoff.* Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) *Environmental Assessment.* Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A Guide to the Procedures.* HMSO, London.

English Nature (1994a) *Roads and nature conservation. Guidance on impacts, mitigation and enhancement.* English Nature, Peterborough.

English Nature (1994b) *Nature Conservation in Environmental Assessment.* NRA, Bristol.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land Contamination & Reclamation,* 1 N° 4, 197-200.

Institute of Environmental Assessment (1993a) *Guidelines for landscape and visual impact assessment.* IEA, Lincoln.

Institute of Environmental Assessment (1993b) *Guidelines for baseline ecological assessment.* IEA, Lincoln.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges.* CIRIA Report 142. Construction Industry Research and Information Association, London.

NRA (1992a) *Policy and practice for the protection of groundwater.* HMSO, London.

NRA (1992b) *River corridor surveys: methods and procedures.* Conservation Technical Handbook N°1. National Rivers Authority, Bristol.

NRA (1993a) *Design and operation of trash screens - interim guidance notes.* Pamphlet P-126. NRA, Bristol.

NRA (1993b) *River landscape assessment: methods and procedures.* Conservation Technical Handbook N° 2. National Rivers Authority, Bristol.

NRA (1994a) *Contaminated land and the water environment.* Water Quality Series N°15. HMSO, London.

NRA (1994b) *Guidance for the control of invasive plants near watercourses.* National Rivers Authority, Bristol.

NRA (1994c) *Abandoned mines and the water environment.* Water Quality Series N°14. HMSO, London.

NRA (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

Wozniak, S.J. (1993) *Environmental assessment of buildings and building development.*

## Appendix 1 - other guidance

Scoping and more detailed guidance notes are available from the NRA for the following development types:

Reservoirs
Marinas
Barrages
Fish farms
Pipelines
Sea outfalls
Points of large abstraction
Points of large discharge
Sewage treatment works - extension and installation
Large residential developments
Large industrial/manufacturing developments of operations
Golf courses
Power stations
Wind farms
Hydroelectric power
Oil refineries/oil exploration
Forestry
Redevelopment of contaminated land
Waste management
Mineral extraction - mining and quarrying
Restoration of mineral extraction sites - landfill and recreation
Roads and road widening
Railways
Airports
Cemeteries
Navigation issues

At present scoping guidance alone is available for the following development types:

Navigation works
Channel works
Flood diversion channels
Fluvial dredging
Bank protection
Flood storage area
Flood embankment
Culverts and tunnels
Barriers/Bridges/Weirs
Off-line ponds and reservoirs
Coastal protection
Beach nourishment

Suction dredging
Restoration and enhancement
Conservation enhancements
Water-based recreation
Off-road recreation
Vegetation management
Deliberate introduction of species
Groundwater abstraction
Interbasin transfer of flow
Agriculture
Kennels, catteries and stables
Intensive livestock/poultry units
Tipping/dumping
Camping and caravan sites
Septic tank/cesspits etc.
Vehicle parks/plant hire
Swimming pools
Chemical storage units
Petrol stations
Peat extraction
Bait digging
Pest species control

## Appendix 2 - NRA contacts

Your first point of contact is your local NRA office. To identify your nearest office please refer to the map on page 1/21.

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| **Anglian** | | | |
| Northern Area | Area Planning Manager<br>NRA Anglian<br>Aqua House<br>Harvey Street<br>LINCOLN LN1 1TF | 01522 513100 | 01522 512927 |
| Central Area | Area Planning Manager<br>NRA Anglian<br>Bromholme Lane<br>Brampton<br>Huntingdon<br>CAMBS PE18 8NE | 01480 414581 | 01480 413381 |
| Eastern Area | Area Planning Manager<br>NRA Anglian<br>Cobham Road<br>IPSWICH IP3 PJE | 01473 727712 | 01473 724205 |
| **Northumbria & Yorkshire** | | | |
| Northumbria Area | Planning Liaison Officer<br>NRA Northumbria &Yorkshire<br>Tyneside House<br>Skinnerburn<br>Newcastle Business Park<br>NEWCASTLE UPON TYNE<br>NE4 7AR | 0191 2034000 | 0191 2034004 |
| Dales Area | Planning Liaison Officer<br>NRA Northumbria &Yorkshire<br>Coverdale House<br>Aviator Court<br>Amy Johnson Way<br>Clifton Moor<br>YORK | 01904 692296 | 01904 693748 |
| Southern Yorkshire | Planning Liaison Officer<br>NRA Northumbria & Yorkshire<br>Olympia House<br>Gelderd Lane<br>Gelderd Road<br>LEEDS LS12 6DD | 01132 440191 | 01132 312116 |

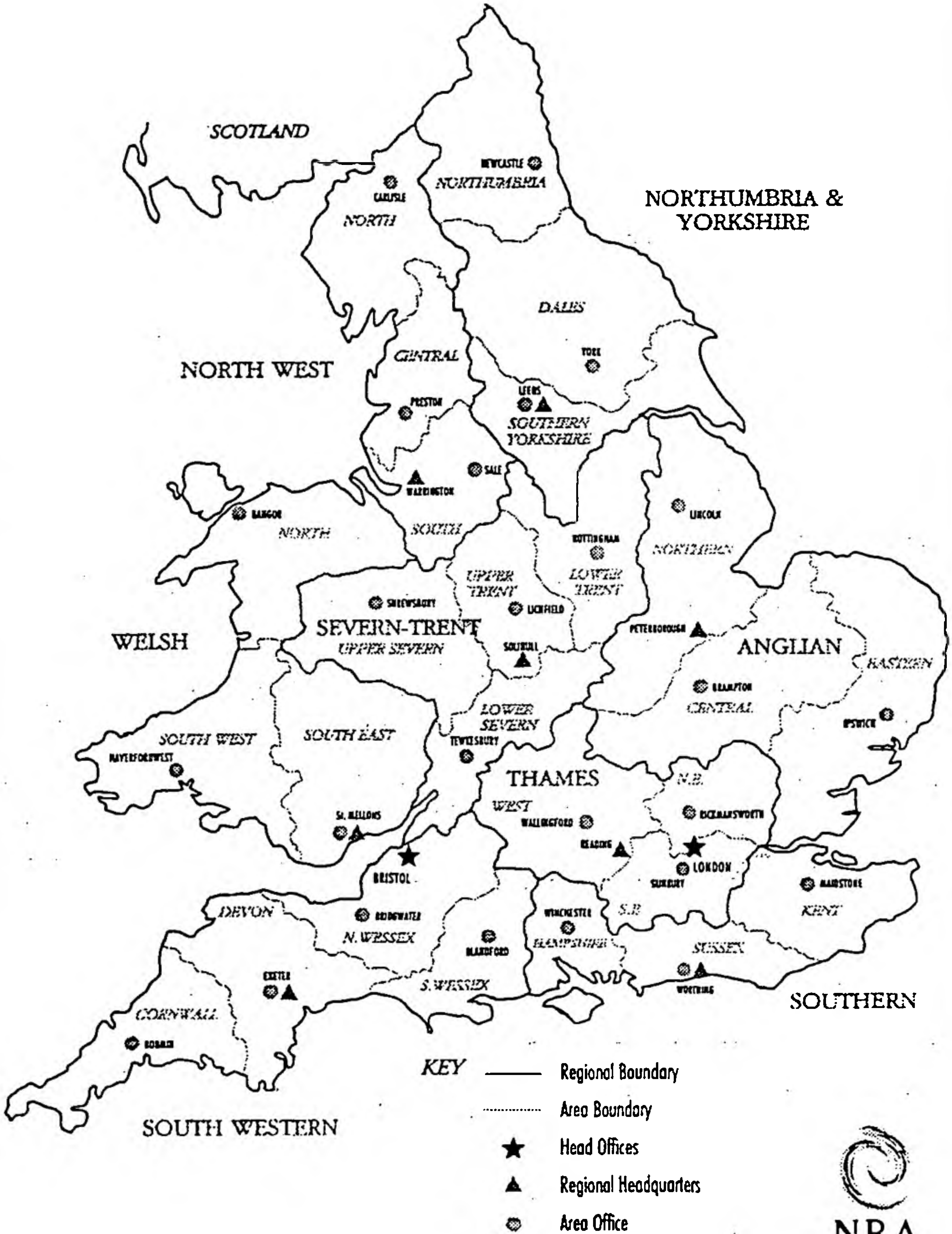
| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| North West | | | |
| Northern Area | Planning and Services Manager<br>NRA North West<br>Chertsey Hill<br>London Road<br>CARLISLE CA1 2QX | 01228 25151 | 01228 49734 |
| Central Area | Planning and Services Manager<br>NRA North West<br>Lutra House<br>Dodd Way<br>Walton Summitt<br>Bamber Bridge<br>PRESTON PR5 8BX | 01772 39882 | 01772 627730 |
| Southern Area | Planning and Services Manager<br>NRA North West<br>Mirwell<br>Carrington Lane<br>SALE M33 5NL | 0161 973 2237 | 0161 973 4601 |

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| **Severn-Trent** | | | |
| Upper Severn Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Hafren House<br>Welshpool Road<br>Shelton<br>SHREWBURY SY3 8BB | 01217 112324 | 01217 115824 |
| Lower Severn Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Riversmeet House<br>Northway Lane<br>TEWKESBURY GL20 8JG | 01684 850951 | 01684 293599 |
| Upper Trent Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Sentinel House<br>9 Wellington Crescent<br>Fradley Park<br>Lichfield<br>STAFFS SW13 8RR | 01543 444141 | 01543 444161 |
| Lower Trent Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Trenside Office<br>Scarrington Road<br>West Bridgford<br>NOTTINGHAM NG2 5FA | 01159 455722 | 01159 817743 |

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| **Southern** | | | |
| Hampshire & Isle of Wight | Planning Liaison Manager<br>NRA Southern<br>Sarum Court<br>Sarum Road<br>WINCHESTER<br>HANTS | 01962 713267 | 01962 841573 |
| Kent Area | Planning Liaison Manager<br>NRA Southern<br>Millbrook House<br>114 Mill Street<br>East Malling, Maidstone<br>KENT ME19 6BU | 01732 875587 | 01732 875057 |
| Sussex Area | Planning Liaison Manager<br>NRA Southern<br>3 Liverpool Gardens<br>Worthing<br>WEST SUSSEX BN11 1TF | 01903 215835 | 01903 215884 |
| **South Western** | | | |
| Cornwall Area | Regulation Officer<br>NRA South Western<br>Sir John Moore House<br>Victoria Square<br>Bodmin<br>CORNWALL PL31 1EB | 01208 78301 | 01208 78825 |
| Devon Area | Regulation Officer<br>NRA South Western<br>Manley House<br>Kestrel Way<br>EXETER EX2 7LQ | 01392 444000 | 01392 444238 |
| North Wessex Area | Regulation Officer<br>NRA South Western<br>Rivers House<br>East Quay<br>SOMERSET TA6 4YS | 01278 457333 | 01278 452985 |
| South Wessex Area | Regulation Officer<br>NRA South Western<br>Rivers House<br>Sunrise Business Park<br>High Shaftesbury Road<br>BLANDFORD DT11 8ST | 01258 456080 | 01258 455998 |

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| **Thames** | | | |
| North East | Senior Planning Liaison Officer<br>NRA Thames<br>Gade House<br>London Road<br>Rickmansworth<br>HERTS WD3 1RS | 01992 635566 | 01992 645451 |
| South East | Senior Planning Liaison Officer<br>NRA Thames<br>Sunbury Yard<br>Riverside Works<br>Fordbridge Road<br>Sunbury on Thames<br>TW16 6AP | 01932 789833 | 01932 786463 |
| West Area | Senior Planning Liaison Officer<br>NRA Thames<br>Isis House<br>Howberry Park<br>Wallingford<br>OXON OX10 8BD | 01734 535000 | 01734 535900 |
| **Welsh** | | | |
| Northern | Development Liaison Officer<br>NRA Welsh<br>Bryn Menai<br>Holyhead Road<br>Bangor<br>GWYNEDD LL57 2EF | 01248 370970 | 01248 370747 |
| South Eastern Area | Development Liaison Officer<br>NRA Welsh<br>c/o Rivers House<br>St Mellons Busoness Park<br>St Mellons<br>CARDIFF CF3 0LT | 01222 770088 | 01222 798555 |
| South Western Area | Development Liaison Officer<br>NRA Welsh<br>Lys Afon<br>Hawthorn Rise<br>Haverfordwest<br>DYFED SA61 2BH | 01437 760081 | 01437 760881 |

# *NATIONAL RIVERS AUTHORITY*
## *Office Location Plan*




NRA

## Appendix 3 - Pollution Prevention Guidelines

1 General guide to the prevention of pollution of controlled waters
2 Above ground oil storage tanks
3 The use and design of oil separators in surface water drainage systems
4 Disposal of sewage where no mains drainage is available
5 Works in, near or liable to affect watercourses
6 Working at demolition and construction sites
7 Fuelling stations: construction and operation
8 Safe storage and disposal of used oils
9 The prevention of pollution of controlled waters by pesticides
10 Pollution from highway depots
11 Preventing pollution on industrial sites
12 Prevention of pollution of controlled waters by sheep dip
13 High pressure water & steam cleaners
14 Inland waterways: marinas and craft
15 Retail food stores and similar sites
16 Schools and educational establishments
17 Dairies and other milk handling operations
18 Spillages and fire fighting runoff

In preparation:

19 Dairies
20 Airfields
21 Timber treatment plants
22 Garages

Note that these notes may be referred to as PPGs but should not be confused with the Government Planning Policy Guidance series (also known as PPGs).

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF RESERVOIR PROJECTS

## 1. Introduction

This guidance note seeks to identify the potential impacts of reservoirs upon the water environment. It is intended to form the basis of a detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of reservoir schemes. The NRA has an interest in reservoir projects owing to its statutory responsibilities with respect to water resources and the general aquatic environment. As such, the NRA will require certain environmental information and, preferably, an environmental assessment. The responsibility for such an assessment lies with the developer. The conclusions of the EA will require proper justification and raw data should be accessible.

There are distinct advantages in conducting EA in advance of detailed planning with the proper consideration of alternatives. In addition, the early involvement of the NRA will help to identify the environmental constraints of the scheme, such as sensitive areas to be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

The developer should refer to NRA catchment management and flood protection plans where these exist. In addition, there may be relevant provisions by the NRA in local plans.

Fundamentally, the need for a reservoir should be adequately justified. The NRA will require a convincing case to be made which shows that other alternatives have been properly investigated and shown to have greater adverse environmental impacts. It should be demonstrated that all existing licensed sources are being used fully and effectively and that reductions in demand have been investigated, such as water conservation and leakage control measures.

A variety of literature is available, particularly in relation to the Cow Green, Craig Goch, Kielder and Roadford (instream) reservoirs (e.g. MAFF/NWC 1976, Brooker 1981, Milner *et al.* 1981, Crisp *et al.* 1983, Cave 1985, Lawson *et al.* 1991 and various unpublished reports). The Construction Industry Research and Information Association have recently produced a manual (CIRIA 1994) on the environmental impacts of construction schemes, including reservoirs as water engineering projects.

## 2. Development control

Reservoirs come under the Town and Country Planning system and therefore require planning permission from the Local Planning Authority.

Reservoirs may be developed in a variety of forms and thus may have differing potential impacts and controls. Fundamental differences will occur between a reservoir that is "instream", i.e. an interrupted part of a watercourse, and one that is "off-line", i.e. a pumped storage reservoir that is remote from a watercourse and receives water pumped directly from rivers. Storage reservoirs of treated water from water treatment works are not considered; the impacts of these are similar to those of a constructed building. Both instream and pumped storage reservoirs may be developed as hydroelectric schemes, which may have additional impacts in relation to the release regime for power generation. The release regime of instream reservoirs without generation will have important, but less drastic impacts. For some reservoir developments, water may be transferred from one river catchment to another leading to a additional concerns on the two catchments affected, most notably, perhaps, being the possible effects on the homing abilities of migratory fish in the mixed river waters.

Excavated reservoirs may be complicated by regulations affecting mineral extraction (see guidance note on mining and quarrying).

## 3. Environmental Assessment

Reservoirs are classified as Schedule 2 developments under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 N° 1199) and therefore a formal Environmental Statement will be required if a reservoir is expected to have 'significant' effects.

## 4. NRA licences

Both **abstraction** and **impounding licences** will be required by the NRA. **Discharge consents** may be required for dewatering operations during construction and will be required for any planned discharges from water treatment works associated with the reservoir. There will be certain requirements for discharges from instream reservoirs with respect to flow and water quality.

A **land drainage consent** will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Land drainage consents are issued under Sections 109 and 110 of the Water Resources Act 1991 for designated main rivers. For non-main rivers this is covered under Section 23 and 24 of the Land Drainage Act 1991. Local authorities and Internal/Inland Drainage Boards also have responsibility for the latter.

A **navigation consent** or licence will be required to undertake works in, on or over a navigable river where the NRA is the navigation authority.

If stocking of fish into the reservoir planned, a **fisheries consent** is required from the NRA for the introduction of fish into an inland water under Section 30 of the Salmon and Freshwater Fisheries Act 1975.

## 5. Major/Potential impacts

### 5.1 Construction impacts

The period of construction is defined as the time to when the reservoir is filled. Many of the impacts associated with the flooding of land in unlined reservoirs (e.g. terrestrial habitat loss) would occur earlier in lined reservoirs with the installation of the lining.

### 5.1.1 Water quality

Bad practice in the storage, handling and disposal of spoil, chemicals and containers, oil, fuel and cement, and the discharge of water from dewatering operations may lead to water pollution. Runoff from vehicle storage areas and access roads can have potentially adverse water quality impacts, particularly with respect to oil and suspended solids. Dam material may also be a significant source of solids entering watercourses. Disturbance of contaminated land may result in increased leaching of contaminants into surface and groundwaters. (The proximity of a reservoir to contaminated land may be a major limiting factor in its approval). Other potential impacts may arise from the sewerage arrangements for construction and, later, operational staff. Also, the construction of the reservoir may necessitate the relocation of pipelines (e.g. sewage) which may lead to further impacts.

### 5.1.2 Flood defence

Where reservoirs are to be constructed instream or otherwise in the vicinity of watercourses, debris from tree felling and general construction works may lead to the blockage of such watercourses, increasing flood risk. During construction there may be a loss of flood plain capacity.

### 5.1.3 Conservation

Bankside tree removal will have a direct impacts as a loss of bird and bat roosting sites, the loss of bank stability and loss in landscape/amenity value. The stripping of topsoil before lining (or flooding) of the reservoir will lead to a general loss of surface cover with the possibility of increased soil erosion, increased sediment load in rivers, altered infiltration (possibly with increased runoff) with resultant effects upon aquatic flora and fauna. In addition, compaction of reservoir banks by heavy machinery may lead to a loss in bank stability and the destruction of soil structure.

Noise and general intrusive activities during construction will lead to the disturbance to fauna in the vicinity of construction and possibly the outward migration of sensitive species.

In-channel work may disturb wildlife and act as a barrier to migrating fish. In addition, habitat changes may occur as a result of the temporary diversion of streams, losses of river substrate and changes to channel geomorphology.

The creation and use of vehicle access roads may lead to impacts of habitat loss, soil erosion and compaction, noise and other disturbance. The laying of water distribution and other pipelines may lead to similar impacts.

Sites of archaeological interest may be disturbed by construction. The excavation of dam material may leave a scarred landscape.

### 5.1.4 Recreation

During construction there may be restrictions of access to the river.

## 5.2 End state/Operational impacts

The major end state impacts of reservoirs of interest to the NRA are those on water resources, water quality, fisheries, conservation and recreation.

### 5.2.1 Water resources

Whilst the development of a reservoir will increase the water resource available distribution network, water resources may be affected in the source catchment, with implications to both groundwaters and surface waters. Where reservoirs are lined, groundwaters may suffer from the general loss of recharge capacity. Changes to groundwater flow may be expected from both lined and unlined reservoirs. Adjacent land may be affected by changes to water table level. Impoundment of surface waters will affect downstream flows and sedimentation patterns, with resulting impacts on fisheries, stream ecology, conservation and navigation. The significance and extent of downstream effects will largely depend on hydrological changes brought about by reservoir operation and the nature of the catchment.

### 5.2.2 Water quality

The source and downstream waters will have water quality objectives protected by water quality standards (WQSs). It will be necessary to demonstrate that the standards set are not adversely affected by the development. If the reservoir is identified as a "controlled water", WQSs may be applied to the reservoir itself. Reservoirs may also fall under the definition of a "sensitive" water under the terms of the Urban Waste Water Directive thus requiring control on the discharges of nutrients from sewage works upstream.

The water quality of the reservoir will be very much dependent on the quality of source waters, which will need to be protected for the use of water abstracted for potable supply. Reservoir water quality will vary from that of river sources as a result of impounding water with an increased retention time and from influences of the flooded land when a reservoir is unlined. In addition, water treatment practices may affect reservoir water quality. For instance, the direct addition to the reservoir of ferric sulphate to remove phosphorus will raise dissolved sulphate levels and give rise to a ferric phosphate floc. The indirect re-circulation or accidental spillage of chemicals used in water treatment works, such as aluminium sulphate, may lead to elevated levels of these in the reservoir, downstream waters and public supply. Impacts on water quality may also affect the potential quality of water for potable supply. Interbasin transfers of water in connection with reservoir developments may lead to changes in the chemical equilibrium of the recipient watercourse and impacts on ecology. (See separate scoping guidance).

**Nutrients and algal growth** - Algal growth will be primarily affected by retention time and nutrient inputs from source waters, sediments and the atmosphere. The coloured appearance of water due to algal blooms may be aesthetically detrimental as would be algal scums, usually due to blooms of blue-green algae. The latter may also have toxic effects on both aquatic (e.g. fish) and terrestrial organisms (e.g. dogs). The collapse of algal blooms may have severe effects on dissolved oxygen levels, particularly when coinciding with thermal stratification, should it occur. Growths of fixed or filamentous algae may also cause some aesthetic and water quality problems. Algae may cause taste problems and algal breakdown products may combine with disinfectants to produce chemical contamination of waters, necessitating further treatment. Algal or nutrient control techniques may have impacts on water quality.

**Suspended solids** - The construction of an instream reservoir will lead to sedimentation within the impoundment and the loss of sediment and suspended solids to downstream areas. Where loads of suspended solids are particularly high, there may be implications for the longevity of the reservoir, dredging needs and the impacts of these.

**Other contaminants** - There may be mobilization of chemicals from flooded areas in unlined reservoirs depending on the geology and past and present uses of the land. Leaching of toxins from contaminated land could lead to severe and prohibiting water quality problems. Particularly where thermal stratification occurs, the water in the bottom layers of the reservoir (hypolimnion) will demonstrate different characteristics to those of the upper epilimnion. The hypolimnetic water may have a lower temperature, dissolved oxygen and algal concentrations, but raised iron, manganese and phosphorus levels. These parameters will have an impact downstream through the precipitation of iron and temperature effects on the life cycles of invertebrates and the timing and success of the hatching, emergence and feeding of salmonid fish. Levels of bacteria and viruses in the reservoir will determine the recreational uses of the water body permitted by local health authorities and also the health risks to users. The use of powered boats on the reservoir may result in problems with oil pollution and surface oil films.

### 5.2.3 Recreation and amenity

The development of a reservoir will affect many of the previous uses of the flooded area, but these may be compensated for by opportunities, particularly for water-based sports on the new water body. However, the impacts of such developments will require consideration.

### 5.2.4 Flood defence

Depending upon design, a reservoir may have positive or negative effects on flood defence. A raised bunded design within a floodplain will reduce flood plain capacity, an instream reservoir will potentially increase storage capacity.

### 5.2.5 Conservation and wildlife

The fundamental change in habitat from a river valley or predominantly terrestrial habitat will be reflected by changes in communities associated with the reservoir. A still water community will develop which will be influenced by the reservoir water source. Impounded rivers may retain many features in both the reservoir and downstream. The reservoir is likely to have positive benefits, becoming utilized by a variety of wildfowl, including those birds resident all year and seasonal visitors. However, riverine species such as dippers and kingfishers may be adversely affected.

Downstream of impounded reservoirs the community will be influenced by the quality of water discharged and the flow regime. Filter-feeding invertebrates will benefit from the development of algae and other plankton discharged with reservoir water. Inadequate compensation flow may lead to a loss of downstream aquatic habitat and reductions in the frequency and magnitude of flood events may lead to changes in the ecology of flood meadows and other wetlands.

The nature of the margins of the reservoir will depend on design, but their ecology will be influenced by the dewatering effect of drawdown, and practices of management for the banks, such as mowing regimes, the use of weedkillers, and the extent of public and animal access. The margins and reservoir itself may be more likely to freeze in winter conditions which may lead to thermal and physical damage and water quality impacts.

The reservoir will have a major impact on the landscape, with a large water body replacing whatever previous features existed. The dam wall may be a particularly prominent feature.

Flooded areas may become of historic/landscape interest at times of drought when buildings are revealed.

### 5.2.6 Fisheries

Where instream reservoirs are constructed there will be impacts on migratory fish due to the physical barrier to migration in the form of the dam. Migration patterns may also be affected by the water quality of discharges and downstream flow regimes. Resident fish will be affected by both changes of habitat within the reservoir and downstream, where spawning areas may become affected by siltation and dewatering. Particularly where there is the creation of a new off-river impoundment, there will be the creation of a potential still water fishery. On some reservoirs, fish cages have been installed for reservoir stocking or fish farming purposes. The use of such cages may have a variety of possible impacts, particularly on fisheries and water quality, and should not occur without prior consent of the NRA. Drawdown may effect the survival of fish species such as char and coregonids that may utilize marginal areas for spawning and may be sensitive to temperature fluctuations associated with variable water depth.

The "homing" ability of migratory fish may be disturbed by interbasin transfers of water away from original nursery streams.

### 5.2.7 Navigation

Instream reservoirs may impact upon navigation of the river. Obstructions in flooded areas may present a navigational hazard within the reservoir.

## 5.3 Dam failure

The unlikely failure of a reservoir dam or retaining wall could potentially result in catastrophic flooding and great losses to both natural and human environments. The risk of failure will be greater in areas prone to seismic activity.

(Reservoirs impounding more than 25000 $m^3$ come under the provisions of the Reservoirs Safety Act and have to be registered with the County Council and inspected regularly by a Panel Civil Engineer.)

## 6. Mitigation measures

Various mitigation measures should be considered as required by the NRA. In particular, the justification for the reservoir and alternative sites and sources of supply should beconsidered. Section 16 of the Water Resources Act 1991 requires that structures such as reservoirs enhance the environment ('further the conservation and enhancement of natural beauty and conservation of flora, fauna and geological or physiographical features of special interest'). This is a duty imposed on both water undertakings as promoters and on the NRA in considering the proposals, and should be regarded as a fundamental part of the scheme. The NRA have published an environmentally sustainable water resources development strategy (NRA 1994).

Intakes of off-line pumped storage reservoirs should be designed so as to minimize risks of entrainment or entrapment to fish and other aquatic life. Further guidance is available in Solomon (1992) and a guidance note on points of large abstraction.

Water quality impacts of discharges from the reservoir may be reduced by aeration and variable level off-takes. The latter may also be required to attain good water quality for drinking water supply. Mixing of reservoir water may bring benefits to both downstream and drinking water quality. Such measures, usually to combat problems caused during thermal stratification, may only be required in summer months following dry periods with little wind. The mobilization of chemicals (nutrients, organics, iron, manganese etc.) from the bottom substrate may be reduced by stripping of topsoil, vegetation etc. in the construction of the reservoir or by lining it. Eutrophication problems may be relieved by control of nutrient inputs, such as through reductions of fertilizer and water treatment, or by destratification.

Competing water requirements should be considered. For example, downstream of instream reservoirs, compensation flows and flow regimes should be suitable to fisheries, wildlife and abstracters downstream. Fish spawning areas should not vulnerable to dewatering by maintaining flows (and reservoir height) during times of spawning. In addition to compensation flows, 'releases' of water to simulate high flow conditions may assist fish migration and recreational uses such as canoeing. Such releases may also be used to relieve water quality problems in the river or estuary, which may often concur with low river flows. The additional capacity for releases should be planned at an early stage. Abstraction to pumped storage reservoirs should be conducted at times of high river flow.

Suitable design with an operational use of the reservoir at a less than 100% capacity may allow for some flood storage.

Temporal and spatial zoning of use of the reservoir will reduce conflicts between users and provide havens for wildlife. Strict seasonal controls of disturbance may reduce the risks of disturbance to protect breeding and overwintering birds. Nature conservation may be higher priority use of water space than recreation, particularly active and noisy sports. Access to the reservoir for various recreational activities should be maintained or developed in accordance with such zoning.

Where the reservoir interrupts the passage of migratory fish, the provision of a fish pass would reduce this impact. The loss of upstream spawning areas may more generally be compensated for by the provision of hatchery facilities and stocking of juvenile fish at various stages.

Where a reservoir fishery is planned, stocking of the reservoir with fish may produce a fishery more rapidly, although for instream reservoirs stocks from within the river catchment should be utilized where possible to preserve genetic integrity. Fish production may be enhanced by the habitat improvement measures such as the provision of artificial reefs. Retaining natural features such as rocks and trees in areas to be flooded may also be useful in this regard. Angling quality may also be enhanced by the provision of landing stages and boats.

The margins of the reservoir may be contoured or otherwise developed to provide habitats of variable depth. However, the reservoir design should consider filling and drawdown regimes and the impacts on wildlife. Small ponded areas may provide valuable amphibian habitat. In areas likely to be frequented by otters, trees with exposed root systems should be retained and the provision of artificial holts considered.

Natural and manmade features may be retained in the reservoir to provide additional wildlife habitats and also viewpoints of interest at various reservoir levels. Such features should be removed or well marked where they represent a hazard to navigation.

Excavation of dam material may be best done locally to reduce impacts of transportation. If excavation occurs within the site of the reservoir, the scarring effect on the landscape will be hidden on flooding.

## 7. Baseline surveys

A variety of surveys should be conducted to ascertain the importance of a site and likely impacts of reservoir construction. The developer should conduct initial desk studies and consult with statutory bodies, including the NRA, to identify sensitive areas such as:

- river floodplains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- contaminated land likely to lead to polluting runoff or leachate;
- "vulnerable" aquifers outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992); and
- upland areas of catchments with particular sensitivities

The NRA will provide information on the relevant data it has. In addition, the NRA will require the developer to review other information sources and provide further baseline information. Surveys will generally be required using relevant timescales and recommended methods. The surveys required will be case-specific but would generally include the following:

- river corridor surveys;
- aquatic biology;
- fisheries;
- landscape/amenity;
- recreation;
- soils;
- geology;
- hydrogeology;
- water quality;
- hydrology and drainage; and
- geomorphology.

## 8. Monitoring and audit

Monitoring should be conducted after and, if appropriate, during construction to assess the effects of the development. Monitoring programmes should be relevant to the predicted impacts and remedial/mitigation works and over a relevant timescale.

## 9. General guidance and references

Brooker, M.P. (1981) The impact of impoundments on the downstream fisheries and general ecology of rivers. *Applied Biology*, **6**, 91-152.

Cave, J.D. (1985) The effects of the Kielder scheme on fisheries. *Journal of Fish Biology*, **27** (Supplement A), 109-121.

Construction Industry Research and Information Association (1994) *Environmental Assessment.* Special Publication 96. CIRIA, London.

Crisp, D.T., Mann, R.H.K. and Cubby, P.R.(1983) Effects of regulation of the River Tees upon fish populations below Cow Green reservoir. *Journal of Applied Ecology*, **20**, 371-386.

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NRA (1992) *Policy and practice for the protection of groundwater.* HMSO, London.

National Rivers Authority (1994) *Water: nature's precious resource. An environmentally sustainable water resources development strategy for England and Wales.* HMSO, London

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## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF MARINAS

### 1. Introduction

This guidance note seeks to identify the potential impacts of issues relating to marinas upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of marina schemes. The potential impacts of marinas are of interest to the NRA because of the authority's responsibilities for water quality, water resources, flood defence, fisheries, conservation, recreation and, in some areas, navigation.

Proposed marina developments may require EA is carried out under the relevant regulations. Where an EA is not formally required, the EA process may remain a useful means of conveying environmental information to those commenting on the proposals. The responsibility for obtaining information and/or an EA lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of the proposed development; enabling environmental constraints to be identified and avoided, and appropriate mitigation to be designed into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives.

### 2. Development control

The development control mechanism for marinas will generally be via the Town and Country Planning system in areas under the jurisdiction of local authorities (i.e. inland and some coastal areas). Other sectoral controls may be relevant in both these and other areas, e.g. the Department of Transport has powers control works affecting navigation and the Ministry of Agriculture, Fisheries and Food has powers to control construction projects in the sea.

### 3. Environmental Assessment

Yacht marinas are listed as Schedule 2 projects in the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI No. 1199) and therefore require EA where significant impacts are expected. General guidance on the assessment of significance is set out in DoE Circular 15/88 (WO Circular 23/88) and DoE/WO (1989); key factors in marina developments are likely to be their physical scale size and proximity to sensitive locations. Guidance on the need for EA are also given in Department of the Environment Circular 3/95 (Welsh Office 12/95) for marinas (and harbours) in the context of permitted development.

### 4. NRA authorizations

The following licences/consents may be required from the NRA in connection with the development.

i. **Land drainage consent** - will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

ii. **Abstraction/impounding licence** - for abstraction or impoundment of water.
iii. **Discharge consent** - for discharges of trade or sewage effluent to inland and coastal surface waters, and groundwaters.
iv. **Navigation control** - for the construction of works on, in or over a river.

## 5. Major potential impacts

### 5.1 Construction issues

The impacts of even small marina developments are potentially very significant due to their essential proximity to watercourses or water bodies. Marinas may be built in lakes, rivers, estuaries or coastal locations. Similar types of impacts may be expected for the different locations, although terminologies may be different, e.g. impacts on river flow may be similar to those on tidal currents, those on riverbanks similar to those on coastal shores. Potential impacts are described using a predominantly river-based outlook, rivers being a key area of NRA concern (and jurisdiction). The impacts of associated infrastructure, e.g. buildings and roads, are discussed in more general guidance on construction. A report by the Construction Industry Research and Information Association (CIRIA, 1994) also discusses the impacts of river and coastal engineering.

**Land take** - Marina developments involve some degree of land take, this includes the aquatic area.

**Preparation of the working area and construction of buildings access roads etc.** Site preparation works may result in damage to the site fauna and flora from direct damage and physical disruption of bankside soils and riverine sediments. Excavation may unearth and damage archaeological interests. The temporary disposal of excavated materials may extend the affected area. Bankside operations may also cause bank instability.

Fauna may be affected by habitat loss both within the water channel and on the bankside, e.g. bankside trees and vegetation may be used by birds and bats as nesting or roosting sites. In addition, trees may also provide shade; tree loss may result in raised water temperatures, and problematic algal growth.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. Runoff and soil disturbance may lead to increased soil erosion with an associated increased sediment load in rivers. High suspended solid loadings reduce water quality and have direct impacts on flora and fauna and the aesthetic appearance of a watercourse. Sedimentation of solids will in turn alter substrate quality for invertebrates and plants, and organisms favouring a more silty sediment may become more dominant. Fish spawning areas may be particularly damaged by siltation. Reduced fish stocks or a change in species composition will affect angling quality.

The general operation of machinery and vehicles may contribute to problems of soil compaction and instability. Fuel and oil may leak from vehicles and machinery or be spilt whilst in delivery or storage. This may result in contamination of both groundwater and surface waters. Shuttering release oils may also affect water quality.

**In-channel construction** - The construction of within water structures will inevitably lead to the disturbance of sediments and increase suspended solids. Placing of concrete and cement in river channels may also cause water quality problems.

Major works within or close to the channel are likely to cause disturbance to wildlife and may necessitate a temporary cessation of use for both boat and other users (e.g. fishermen and windsurfers).

Isolation and dewatering of aquatic areas may lead to fish mortalities from altered water quality within the isolated area and physical damage from pumping etc. Diversion of flow around major works, e.g. around coffer dams, may cause erosion of the river bed in the temporarily narrowed channel.

**Geomorphology** - Marina construction will almost certainly result in an altered channel morphology with respect to width, depth, shape, gradient and bedform (riffles, pools etc.) and will lead to an altered deposition regime. Changes in the riverine environment will have an impact on the aquatic fauna and flora.

**Coastal impacts** - In coastal areas construction may similarly affect habitats, fisheries and recreation. The natural processes of erosion and deposition may be altered affecting intertidal habitats, sea defences etc.

## 5.2 Operational issues

There are a variety of operational issues that may have environmental implications, ranging from boat movements on the waterway to dredging to maintain its use for marinas.

**Habitats** - The marina may create a new habitat area of relatively uniform depth but with some habitat complexity from man-made structures, e.g. moorings, pontoons etc. This may be suitable for a different fauna and flora than previously, including fish. There may be a loss of species more associated with flowing waters. The installation of rigid bankside structures may prevent use of the bank as habitat. e.g. for voles, kingfishers etc., and access points for wildlife may also be affected. Boat, vehicle and pedestrian movements may cause habitat disturbance and result in the loss of sensitive species.

**Recreation/amenity** - Marinas themselves will improve recreational facilities for some users, e.g. boat use should increase. However, there may be an aesthetic loss of "naturalness" in rural settings.

**Flow changes** - There will generally be reduced water flow within enclosed marinas. Algal blooms and stagnation in the marina may result in deterioration of water quality. In estuarine areas or areas close to the tidal limit, salinity changes through saline intrusion may occur. Freshwater species may be lost, fish populations and movements may be altered and recreational activities, such as angling, affected. There may be a localized rise in the water table adjacent to enclosed marinas.

**Locks** - Marinas may require locks to maintain access to waterways, particularly in estuarine areas. However, the use of locks will also have a flow regulation effect with intermittent flows downstream and may act as a barrier to fish migration and movement and cause disruption to existing navigation rights. However, the installation of use of locks will generally improve access for boats and may also have a flood defence function. Locks may also provide pedestrian crossing points and amenity areas.

**Boats** - Pollution may be caused through the release to the waterway of oil/fuel, chemical or organic waste (e.g. "grey" water and sewage). Also, rubbish may be accidentally or deliberately released from boats. Chemicals in antifouling paints may gradually seep into the water and reduce water quality, particularly in marinas and docks where is a high boat density and a low rate of water exchange. This can lead to the build up of high levels of contaminants in these areas in water and sediment.

Boat hull cleaning may result in the loss of antifoulant paint residues to water.

Pollution from marinas may affect the quality of adjacent fisheries, including shellfisheries which may be particularly affected by contamination from bacteria, heavy metals and oil.

**Boat movement** - waves and so-called "boat-wash" may cause erosion of the banks and/or riverbed, bankside habitats and wildlife, and result in high levels of solids maintained in suspension and increased channel width. Nesting birds may be disturbed. Increased sediment loads may lead to increased turbidity and sedimentation downstream. Pollution may be caused through the resuspension of contaminated sediments. Boat-wash and movements may also disturb anglers and other users (e.g. commercial navigation), resulting in conflicts between user groups. Moored boats may block access to the river for anglers and other users.

**Dredging** - From time to time marinas and navigation channels may need to be dredged, resulting in various impacts. Navigation may be disrupted whilst the dredging operations are underway. Dredging operations will decrease the bed load but at the same time cause a loss of stability of bankside and benthic sediments resulting in an increased suspended solid loading, through the remobilization of sediments back into the water column. A variety of contaminants including oil, pesticides, and other chemicals, may be associated with the sediment particles. Eutrophication may also occur. Thus, the net effect may be a reduction in water quality and which may seriously impact on aquatic fauna and flora and other water uses. Bankside users will also be affected as access to the banks may be limited by the temporary deposition of dredged materials along the shoreline. The material will have a physical impact on underlying soils and associated flora and fauna, and may have amenity impacts from its appearance, odour and from flies which are attracted to it. Dredged sediments may also pollute soils and water from leaching and runoff of associated contaminants.

**Buildings and car parks** - Runoff and site drainage are likely to become contaminated with oil and fuel, leading to a deterioration of surface and/or groundwater quality. Waste reception and disposal (including sewage) from boats and land facilities may cause further pollution.

**Chemical storage and use** - Spillage and leakage of chemicals in storage, delivery and in their use may result in contamination of surface and groundwaters.

## 6. Mitigation measures

**Site location** - Sensitive areas should be totally avoided, such as wetlands, saltmarshes, valuable fisheries etc.

**Site design** - At the chosen site location, the more sensitive and important habitats should be avoided and protected. For example, a marina could be constructed below the mean low water level to minimize any impact on the ecological interest of the intertidal area. Permanent and temporary land take should be minimized and original habitat features maintained. Trees and other bat or bird habitats should be retained. Opportunities should be sought to replant appropriate trees and create new habitats.

**Construction practice** - Building regulations, codes of good practice etc. should be followed. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor will be employed to ensure the protection and enhancement of the environment.

**General disturbance** - Disturbance to wildlife, plants and habitats can be reduced by restricting the width of operations and the appropriate phasing of construction work avoiding sensitive times, e.g. sensitive times for bird populations include the breeding season, roosting and migratory concentrations. Noise and intrusion should be minimized and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites.

Similarly, disturbance to recreation caused by construction works can be minimized by timing operations carefully. For example, construction work on locks should be executed outside of main boating season, and alternative access and crossing arrangements should be made. The duration of construction and other works should be minimized without jeopardizing other environmental issues or safety.

**Storage and handling of soil** - Soil handling and storage should be such that the area affected is minimized but the structure of soils to be restored is maintained as much as possible (i.e. avoid mixing topsoil with underlying material). Stored and other exposed soil or spoil should be covered to minimize silt runoff. Imported material should be avoided where this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Opportunities to create wetland or other habitats should be considered.

**Compaction of soils** - Soil compaction by heavy machinery should be minimized, particularly in sensitive sites, with the use of boards and other temporary supporting structures.
**Boat movements** - The imposition of mandatory speed limits on vessels will reduce wave action and the impacts of boat-wash on bank and bed sediments and the aquatic communities. The

number of boats may also be limited. Where marinas are constructed in association with barrages/locks, fish pass facilities should be protected from disturbance by boats.

**Stagnation within locks/marinas** - Stagnation may be prevented by periodic or continuous (trickle) flushing and aeration.

**Dredging** - Dredged material should be disposed of with consideration of the sensitivity of receiving site and the level of sediment contamination in mind. Disposal to landfill may be required for particularly contaminated material. Disturbance to recreational users from dredging activities may be minimized by timing operations carefully.

**Foul drainage** - All foul drainage from the site should be connected to the public drainage system via a private sewer. If this is not possible, suitable private sewage treatment facilities should be incorporated, the discharge from which being subject to consent. Cesspools and septic tanks may also be acceptable for small-scale developments. Direct discharges from boats should be prohibited within marinas (and discouraged generally).

**Chemicals, fuel and oil** - Chemicals etc. should be suitably stored in areas away from sensitive groundwaters, watercourses and drains, with adequate bunding to prevent pollution should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when handling cement or pouring concrete near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects. Sewerage and waste disposal arrangements should be adequately considered.

Locations used for the fuelling of craft should be designed and operated to minimize risks of pollution.

**Contingency plans** - Plans to be used in the event of a major pollution within the marina should be set up. These should include emergency procedures on how to deal with the pollution itself. Where appropriate booms and absorbent should be available. They should be stored so that they are readily accessible and maintained in good condition.

## 7. Baseline surveys

Surveys may be required to ascertain the value and sensitivity of sites to marina developments. Surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case- specific but are likely to include:

- water quality;
- aquatic ecology, e.g. river corridor surveys;
- fisheries;
- recreational use;

- archaeology;
- geomorphology; and
- hydrology.

## 8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended. Monitoring data should be regularly reviewed, such that action may be taken to resolve issues arising.

## 9. References and guidance

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Department of the Environment/Welsh Office (1992) *Planning Policy Guidance: Sport and Recreation*. PPG 17. HMSO, London.

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Humphreys, H. (1994) *National Water Resources Strategy - a strategic overview*. National Rivers Authority, Bristol.

Waggoner, J.P. and Feldmeth, C.R. (1971) Sequential mortality of the fish fauna impounded in the construction of a marina at Dana Point, California. *Fish Game*, 57, 167-176.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF BARRAGE PROJECTS

## 1. Introduction

This guidance note seeks to identify the potential impacts of barrages upon the water environment. It is intended to form the basis of a fairly detailed scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of barrage schemes. The potential impacts of barrages are of concern to the NRA because of the Authority's fundamental responsibilities for environmental protection, pollution control, water resources, flood and coastal defence, fisheries, recreation and conservation management. As such, the NRA will require information on expected environmental impacts in all cases and would wish to see a detailed Environmental Statement (ES) in most.

It is the responsibility of the barrage scheme promoter (or developer) to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Barrages in coastal areas may create potential conflicts in coastal zone management and scheme promoters are referred to Planning Policy Guidance 20 *Coastal Planning* and also to the Government Circular dealing with Development and Flood Risk (DoE Circular 30/92, WO Circular 68/92). Proper justification will be required for any conclusions in an EA and access to the raw data may be required to examine particular issues in more detail.

It must be stressed that there are distinct advantages for the promoter to undertake an EA in advance of planning and licensing applications. Indeed, the early involvement of the NRA will enable the identification of environmental constraints and sensitive areas to be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. The proposed routing of the barrage and an assessment of alternatives should be a part of preliminary consultations.

Barrages are constructed, usually in estuarine areas, for the purposes of urban regeneration, flood defence or power generation. Amenity use is a frequent spin-off benefit. Those constructed in tidal areas may be total exclusion, partial exclusion or tidal barrages. Storm barrages, operated only during storm surges to prevent inland flooding, are a further design. Tidal barrages would principally be used for power generation. Partial exclusion barrages (those allowing limited tidal flow) and total exclusion barrages are the most commonly proposed, usually as an amenity or focus to stimulate the redevelopment of the surrounding area.

Where extensive areas of land are to be developed adjacent to the site of the barrage, there will further environmental assessment implications (e.g. surface drainage and runoff, storage of fuel and chemicals and spillage risk, sewage and other effluent disposal, the development of contaminated land, use of weedkillers) to be considered at an appropriate stage of planning. Other NRA guidance may be appropriate to such additional aspects of a development.

A variety of literature has been produced in association with barrage proposals (e.g. STPG 1989, STPG 1993, EAU 1991). Jones (1994) described the role of the NRA with respect to environmental protection and barrage proposals.

## 2. Development control

In the past, barrages have been promoted as Parliamentary Bills but in the future are most likely to be promoted by means of an Order under the Transport and Works Act 1992. Under this Act the NRA are statutory consultees. Barrages could also potentially be promoted within the Town and Country Planning framework. Proposed barrage developments may also be affected by local byelaws which cannot be accounted for in this general briefing.

## 3. Environmental Assessment

An ES is usually required for a barrage, regardless of the legislative framework under which it is promoted. The Application Rules for an Order under the Transport and Works Act 1992 are such that an ES is normally required (unless the Secretary of State directs otherwise). Hybrid or Private Bills require an ES under the Standing Order adopted in May 1991. Under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988/1199), barrages are classified as Schedule 2 developments and therefore a formal Environmental Statement will be required if a barrage is expected to have 'significant' effects.

## 4. NRA authorizations

The nature of authorizations required from the NRA will depend on the details of a scheme and also the legislative framework under which it is promoted. In general, a licence is required for the impoundment of water. Similarly, licences are required for water abstractions, and for any trade effluent discharges to inland and coastal surface waters that are established during the construction and operation of the barrage. In addition, a land drainage consent will be required for any works on the bed and banks of a river or the construction of any structure likely to impede the flow.

**Land drainage** and **impounding licences** must be obtained in advance of any construction, regardless of whether planning permission has been granted. Similarly, permission to discharge must be obtained prior to operation.

Test pumping of groundwaters will require a consent and active dewatering would be authorized by an **abstraction licence** or a conservation notice.

A **navigation consent or licence** to undertake works in, on or over a navigable river where the NRA is the navigation authority.

If stocking of fish into the barrage impoundment is considered, a **fisheries consent** is required for the introduction of fish into an inland water under Section 30 of the Salmon and Freshwater Fisheries Act 1975.

## 5. Major potential impacts

Impacts upon the aquatic environment are expected in both the construction and operation of the barrage. The EA should state the extent of predicted impacts and whether impacts are temporary

or permanent. In general, the creation of an impoundment in a river or estuary site will have profound and permanent effects on the aquatic ecosystem and, in particular, on migratory fish and water quality. The river, estuary, and coastal waters in the area of the proposed development should have existing water quality objectives and further
objectives should be established for the waters upstream and downstream of the completed barrage. It will be necessary for the scheme promoter to demonstrate by appropriate mathematical modelling that such objectives will not be adversely affected.

## 5.1 Construction impacts

### 5.1.1 Water quality

The construction of a barrage may affect existing water quality due to a variety of factors which will depend on both construction techniques and operations. Examples may include the mobilization of contaminants in sediments, and general increases in suspended solids associated with land and sediment disturbance and movements of soil. There may a risk of pollution from site runoff (e.g. oil, cement) and spillages of fuel etc. and the discharge of water from dewatering operations.

It will be necessary to demonstrate that current water quality objectives are met during the construction of the barrage and necessary pollution control measures taken.

### 5.1.2 Fisheries, conservation, recreation and navigation

**Fisheries**

Fisheries may be affected during construction of the barrage, particularly through obstructions to the passage of migratory fish, e.g. by in-channel work.Water quality changes may create unfavourable conditions for fish life. Restrictions to access for anglers and changes to water depth, flow and quality may have knock-on effects on angling quality and success.

**Conservation**

Construction activities may damage the conservation interests of aquatic and riparian habitats. The stripping of topsoil and general loss of surface cover may lead to the direct loss of habitat and species, and also cause increased runoff and soil erosion with an increased sediment load in the river and estuary. General noise and intrusion may cause disturbance to river and estuary fauna, particularly birds, and the outward migration of sensitive species.

Sites of archaeological interest may be damaged by construction access and activities.

**Recreation**

Recreation and amenity uses of the area may be disrupted by construction operations, such as through limitations of access, noise and visual impact.

### Navigation

Navigation may be impaired during barrage construction.

### 5.1.3 Flood defence

Flood defence may impaired by in-channel obstructions and any breaches in defences made during construction.

## 5.2 End state/operational impacts

### 5.2.1 Water quality

#### Water Quality Objectives

The NRA will specify the water quality objectives for the waters of the impoundment and those upstream and downstream of the newly-created water body. Such water quality objectives may in the future have statutory status; their achievement must be assured. To achieve the water quality objectives specified, the NRA will set appropriate water quality standards. The impoundment may be designated as a "sensitive" area under the Urban Waste Water Treatment Directive and necessitate strict controls on nutrient inputs from sewage treatment works upstream.

It will be necessary for the promoter to demonstrate by appropriate modelling that water quality will not be adversely affected by the construction and operation of the barrage and that specified water quality standards are met at all times.

#### Water quality impacts

Water quality impacts may occur both upstream and downstream of the barrage and are affected by some of the major physical changes in the water body, e.g. changes in tidal flows and sedimentation. The following issues should be considered in the EA.

**Tidal flows** - The creation of an impoundment will interrupt natural tidaland river flows, affecting water velocity and salinity and the flushing and mixing effects of such flows.

**Sedimentation** - Upstream of the impoundment there may be an increased rate of sedimentation, principally due to reductions in water velocity. Depending on the type of barrage, the quantity of maritime sources of sediment may be reduced. Changes in sedimentation patterns may affect water quality, the hydraulic capacity of the barrage and requirements for the physical removal (dredging) of deposits.

Downstream of the impoundment, sedimentation rates and patterns are also likely to be affected, due to changes in tidal flows, flushing and scouring. There again may have implications for dredging requirements and the impacts of these. Similarly, if releases of water from the impoundment are considered for scouring purposes, these may have effects both within and downstream of the barrage, particularly with respect to water quality.

**Salinity** - The salinity of the impounded water and its stability will be a key factor determining the nature of the ecology of impoundment and will be related to the frequency and extent of salt water intrusion, a factor that will vary with the extent of tidal exclusion of the barrage. Saline water entering the impoundment will be naturally denser than fresh water and tend to sink, leading to stratification of the water column. Where barrages are used for power generation upstream salinities may increase as a result of over pumping at high water.

The salinity regime downstream of the barrage will affect the downstream ecology and may have implications for the passage of migratory fish.

**Dissolved oxygen** - The concentration of dissolved oxygen of the impounded water will have major implications for populations of fish and other organisms, and may particularly affect the passage of migratory fish from below to above the impoundment, bearing in mind that fish may remain both downstream and within the impoundment for some time. The downstream passage of fish through the impoundment and barrage structure may also be impaired. Reductions in dissolved oxygen levels are likely to occur due to the reduced flow and mixing of the impounded water. Factors affecting such a decline are the extent of organic enrichment of the water body, temperature, growths of algae and the extent of saline stratification. Undisturbed organic rich sediments will also exert a strong oxygen demand on the overlying water.

Where discharges such as sewage are re-routed downstream of the barrage, there may be implications for downstream water quality, particularly dissolved oxygen and ammonia concentrations. Again, migratory fish and resident species may be affected as these may congregate downstream of the barrage awaiting suitable conditions to enter the impoundment.

**Ammonia** - Ammonia is usually derived from the breakdown of organic wastes and is a significant component of sewage effluents. There may be a significant release of ammonia from organic rich sediments into the impounded water. This is particularly likely to occur if stratification of the water column leads to the formation of a deoxygenated lower layer. The unionised form of ammonia is particularly toxic to fish and the proportion that is unionised is dependent on other water quality parameters, particularly pH, but also temperature, salinity and dissolved solids. Changes occurring to these parameters and to sources of ammonia may alter the concentration of this important parameter, particularly in the impounded water.

**Temperature** - Water temperature regimes may have impacts, particularly through thermal stress to organisms and thermal stratification of the impounded water, which could lead to deoxygenation of the water column. Thermal stress may take effect both directly and indirectly through the reduction of dissolved oxygen levels. Downstream temperatures will be affected by the temperature and volume of water leaving the impoundment and the influence of solar radiation on mud banks exposed at low tide.

Thermal inputs from power stations may be an additional complication and add to the risks of thermal stress. In such cases, there may be the imposition of a temperature standard.

**Nutrients and algal growth** - The creation of an impoundment will generally result in an extended retention time of water in more lentic conditions. Water clarity may increase due to reduced concentrations of suspended solids. Algal growth, which may be stimulated by these conditions, will be dependent on a number of factors, including the concentrations of nutrients derived from upstream sources. In addition, the sediment within the impoundment may become a significant source of nutrients, particularly phosphorus. In general, the coloured appearance of water due to algal blooms is aesthetically detrimental, as are algal scums, usually resulting from blooms of blue-green algae. The latter algae also may have toxic effects on both aquatic (e.g. fish) and terrestrial organisms (e.g. dogs), as may blooms of certain other algae, e.g. dinoflagellates. The collapse of algal blooms may have severe effects on dissolved oxygen levels, particularly when coinciding with thermal or saline stratification. Growths of fixed or filamentous algae may also cause aesthetic and water quality problems.

**Bacteria and viruses** - The levels of bacteria and viruses in the impoundment should be predicted as this will affect the potential uses of the water body. Consultation should occur with appropriate Environment Health Departments of Regional Health Authorities.

**Other contaminants** - The sediment of the impounded water is a potentially significant source of contaminants, both from existing deposits and those anticipated from upstream following impoundment. The extent of contamination of the water column from sediments will be related to disturbance of the sediment (e.g. from boat movements and dredging operations), oxygen levels at the water-sediment surface interface, and food chains involving substrate-dwelling organisms. Organic matter accumulating and depositing in the impoundment will exert an oxygen demand and may affect dissolved oxygen levels. Increased boat usage may also result in unsightly and polluting surface oil films and contamination from antifoulant paints. Rubbish and floating detritus may be unsightly, particularly if caught up in algal scums.

The location of storm discharges occurring both upstream and downstream may impact both aesthetic and chemical water quality, although there should be a presumption against such discharges to the impoundment.

### 5.2.2 Fisheries, conservation, recreation and navigation

The major physical alteration to the aquatic and riparian environment will usually have implications for each of these NRA functions.

**Fisheries**

The NRA will require that the implications of barrage construction on fish species are fully considered. Of particular concern will be effects on migratory fish passing through the area, but the NRA will also require information on resident estuarine, freshwater and, in some cases, marine fisheries. (The term 'fisheries' refers to not only the populations or stocks of fish {per se}, but also the legal and licensed exploitation of these.)

**Migratory fisheries** - The major impact to migratory fish will be due to the interruption of normal river and tidal flows and the creation of a barrier to migration in the form of a barrage, albeit with a fish pass. Patterns of water quality will also influence fish behaviour and water quality gradients may act as 'barriers' to migration. Migratory fish include those migrating from the sea to spawn in estuaries or rivers (e.g. Allis shad, Twaite shad, smelt, salmon, sea trout, river and sea lampreys) and those migrating from rivers to the sea to spawn (e.g. eel and flounder). The flow patterns through the barrage and the efficacy of any fish pass design will influence the degree of impact on the fish species. Impacts may occur in the passage of species both upstream and downstream, although different life stages may be involved. The promoter must identify the nature and scale of any impact on fish passage in both directions for each species of fish and each life stage. Where barrages are used for hydroelectric generation, passage through turbines may be particularly damaging to fish (ETSU 1988). Commercial fisheries are often based in estuaries and may be affected by the presence of a barrage. Recreational fisheries will be affected with changes of access to waters and the availability of fish.

**Estuarine fisheries** - The impact on estuarine fisheries (e.g. sea bass, common goby and various mullet species) will primarily result from losses of estuarine habitat, including spawning and nursery areas. Some fish may be able to utilize the generally more stable environment within the impoundment, depending on salinity tolerance and regime. Again, commercial and recreational fisheries may be affected. In most areas the management of sea fish is not the responsibility of the NRA, although most of the exceptions where the NRA has sea fishery responsibilities lie within estuaries.

**Freshwater fisheries** - The impact on the freshwater fisheries upstream of the barrage will principally be due to the change in habitat from a flowing river to a lentic water body. The water quality and ecological characteristics of the latter will result in a change in fish community type. Species characteristic of flowing waters (e.g. trout, chub and dace) may be replaced by species more characteristic of slow flowing or still waters (e.g. carp and bream). Impacts on recreational fisheries may reflect these changes and the availability of fish. Additional changes may result from any changes of access to the fishery.

**Conservation**

The impact on the flora and fauna of the area will reflect the fundamental habitat changes and general disturbance through recreational and operational practices. Where intertidal areas are lost, bird species utilizing such areas (e.g. waders) will be displaced. Species downstream of the barrage may be affected by changes in flow regimes and water quality, such as turbidity, salinity and nutrient supply. Some fish species of conservation interest (e.g. Allis shad and Twaite shad) will be affected by barrage construction, where these occur. Impacts on both aquatic and terrestrial organisms, including invertebrates and plants should be considered. A number of species are likely to benefit from the creation of an impoundment. Some species may cause aesthetic problems, such as chironomid midge species which may swarm in great numbers upon hatching. Midge problems may only be a short term problem until a balanced ecological community is established in the impoundment.

The timing of operations will be critical in relation to breeding, feeding or other seasonal or diurnal behavioural patterns. The significance of impacts to a particular species will be related, in part, to its regional, national and international rarity. Effects may be brought about by changes to water levels and quality in riparian and other associated habitats, e.g. wetland and drainage ditches.

In addition to impacts on the wildlife of the area, impacts are likely to occur to natural physiographic and geological features. Also, buildings, sites and objects of archaeological or historic interest and the general landscape may be impacted by the construction of a barrage.

### Recreation

Impacts on existing recreational users will primarily result from the suitability of the water body for recreational use. In general, there should be opportunities to develop recreational use of the impoundment, although there may be constraints of water quality, space and the zoning of activities. The public health implications of water contact sports in particular must be fully addressed by the developer and the local authority's department of Environmental Health. Impacts on existing users (bird watching, walking, sailing etc.) may occur from both the construction of the barrage, its operation and the development of recreation on a new impoundment. Also, public access to places of natural beauty or to sites or objects of archaeological, architectural or historical interest may be restricted. The general amenity value of the impoundment and surrounding area may be affected by problems such as algal growths, accumulations of sewage-associated and other litter. The development of midge populations may be a particular short term impact affecting residents and users of the surrounding area.

### Navigation

Navigation will be affected by the construction of a barrage and there would generally be a requirement for locking facilities on the barrage. Impacts on users of these facilities may include general delays and restrictions associated with tidal or barrage operating regimes. Further impacts will result from altered siltation patterns leading to altered channels and dredging requirements. The responsibility for navigation is not usually that of the NRA but rests with the local Navigation Authority. However, in a few instances the NRA will be the local Navigation Authority.

## 5.2.3 Water resources

The creation of an impoundment may affect both the quality and quantity of water resources. Barrages may be constructed specifically for the benefit of water resources.

### Surface water resources

In general, the creation of an impoundment with higher water level of fresh water will accrue a net benefit to abstractors within an otherwise tidal or brackish reach. The water quality of the impounded water may be altered by algal growths and reductions in suspended solid loads. Abstractors such as power stations may be affected by altered discharge requirements resulting from barrage construction.

Barrages constructed as part of hydroelectric schemes may have implications for new abstraction applications from upstream of the scheme, depending on the nature of the scheme and whether abstraction for generation is made a protected right.

### Groundwater resources

The creation of an impoundment with a sustained high water level may have considerable implications for groundwater levels and resources. In general, a higher groundwater level would be expected and this may have consequences for the quality of existing groundwater, a primary NRA concern. Groundwater pollution may occur where rising groundwaters come into contact with contaminated land, such as landfill or coal-gas production sites. Saline intrusion into aquifers may occur if high levels of saline water are retained upstream of barrages. In addition, buildings, other structures and natural systems, such as wetlands, may be affected by rises in water level. Where active dewatering is used to reduce groundwater levels there may be impacts of such operations on both groundwater and surface water quality.

### 5.2.4 Flood Defence

Barrages will generally have implications for flood defence, and may be specifically constructed as a flood defence measure with an appropriate cost-benefit analysis. Impacts will result from a generally higher water level within the impoundment. Sedimentation within the impoundment will lead to a reduced capacity. There are a number of potential primary impacts of a barrage on flood defence interests. There may be both an aggravation or improvement of flood risk, depending on the operation and design of the barrage, tidal and river flow conditions. Agricultural drainage may be impaired due to the interruption of gravity drainage from low lying land adjacent to the impounded area. There may be increased maintenance requirements following barrage construction, e.g. through increased bank erosion.

## 6. Mitigation measures

Alternative routing, designs and operational features of the proposed barrage and the environmental acceptability of each should be broadly considered. For the chosen routing, mitigation options should be carefully considered to reduce the net impact of the development scheme. To achieve environmental protection, the promoter should seek any byelaws necessary. In addition to the barrage itself, the siting of access roads, storage and waste disposal facilities used during construction and thereafter should be considered.

### 6.1 Water quality

During construction, appropriate measures (e.g. bunding) must be taken to prevent pollution from runoff and spillages from the site(s) of operations.

In order to achieve the water quality standards stipulated by the NRA for both the impoundment and downstream of the barrage structure, a number of measures may have to be taken by the developer. These could include: the diversion or improved treatment of effluent discharges; the reprofiling of the channel bottom, facilities for the automatic flushing of the impoundment and/or automated artificial aeration and circulation to prevent the formation of a stratified bottom layer of deoxygenated water; and algal skimmers where algal blooms are predicted to develop.

It will be the responsibility of the developer/promoter to carry out post-construction monitoring in order to demonstrate achievement of water quality standards.

## 6.2 Fisheries, conservation, recreation and navigation

### 6.2.1 Fisheries

Construction activity that interrupts the passage of fish, if unavoidable, should be phased to periods when the impacts on migratory fish are minimal. In operation, there almost certainly will be a requirement for a fish pass to enable the passage of migratory fish. The design of the pass will be subject to approval from the Ministry of Agriculture, Fisheries and Food or the Welsh Office, who are likely to liaise closely with the NRA. It should be noted that fish passes have a poor efficiency, different species require different types of passes, and attraction of fish to the pass is crucial. The operation of the barrage and the fish pass should consider the seasonal and diurnal migration patterns of every migrating species and the influence of flow, temperature and salinity on fish movement. Pre- and post-scheme monitoring by the developer will be required to demonstrate the impact of the barrage. Where detrimental impacts are demonstrated, measures such as fish pass modification, trapping and relocating fish, and fish stocking may be required.

Where the creation of an impoundment results in changes in suitable freshwater fish communities due to alteration of the habitat (e.g. the creation of a still water from a river or estuary), stocking with suitable fish species should occur where stocks do not currently exist to maximize the potential of the fishery, providing there are no impacts on other fisheries (e.g. predation on migratory fisheries). Habitat improvement measures, such as the installation of artificial reefs and shallow weeded areas may benefit fish and other wildlife.

The siting and operation of the barrage should attempt to minimize downstream impacts on estuarine and marine fish. Any abstraction intakes and turbines should be suitably screened to minimize damage to fish.

### 6.2.2 Conservation

Conservation measures might include the creation of artificial tidal lagoons, scrapes, islands, reed beds, areas of variable depth and other habitats. Such habitats should be designed primarily for the species likely to be displaced by barrage construction, e.g. a tidal lagoon for wading birds, but should also be considered to enhance newly created habitats such as a freshwater lake. The operation of the barrage should consider the needs of existing and artificially created habitats. For instance, there may be possibilities to simulate natural tidal regimes with respect to salinity and inundation patterns for tidal barrages, and, if marginal reed beds are planted to enhance a freshwater impoundment, drawdown should be minimized. Disturbance caused by barrage construction and operation should be minimized (particularly with respect to breeding, feeding or roosting birds). The relocation of sessile species should be considered where damage is inevitable.

The barrage development should retain natural features such as trees and grassland, where possible, and even manmade features such as buildings where these are of importance, e.g. as bat roosts. If possible, riparian areas should be maintained with a minimum width and area. Tree planting and landscaping should be considered, particularly in areas affected by the development.

Sites of archaeological and other interest should be preserved *in situ*, where feasible, with the provision of facilities for visitors. However, relocation may need to be considered.

### 6.2.3 Recreation and amenity

The recreation and amenity value of the barrage may be heightened by adequate access and the provision of features for particular users (e.g. ramps and pontoons for sailing, 'pegs' for angling, hides for bird watching).

### 6.2.4 Navigation

Construction works should try to minimize impacts on navigation, minimizing disruption in busy periods, such as the summer, and maintaining access through the barrage where possible, particularly for commercial boats. Adequate locking facilities should be installed for navigation past the barrage, and charges for the use of these should be affordable. The maintenance of navigation channels should be improved, or at least not adversely affected.

## 6.3 Water resources

Residual flows will be important for the fish pass, ecological and other identified needs.

A staged increase in water levels may be necessary to enable assessment of groundwater levels and quality. Adjusting operating water levels in the barrage may reduce groundwater influx. Contingency measures agreed with the NRA should be established to counter problems arising from rising groundwater levels, such as from contaminated land. Staged increases in water level will, however, have impacts on the efficacy of a fish pass, if installed, and fishery needs must be taken into account. There will be a need to budget water requirements in the worst case scenario to protect fish pass operation and downstream effluent dilution, including allowance for maximum possible lock usage etc.

## 6.4 Flood defence

The impacts to flood defence may be influenced by barrage design, principally height, and operating procedures. For example, flood risks may be reduced by discharges from the impoundment in anticipation of high river flows. Operating agreements covering the routine operation and maintenance for the barrage should be drawn up including emergency requirements such as flood warning and systems to respond to events of major flooding. Dredging may be used to maintain the capacity of the impoundment. Where land drainage is impaired by higher water levels, pumping schemes may be of use. Erosion protection measures may reduce bank erosion resulting from barrage construction.

# 7. Baseline surveys

The promoter should ensure that the characteristics of the area of the development are ascertained and sensitive areas identified, such as:

- bird feeding or roosting areas;

- migratory fish movement patterns;
- fish nursery areas;
- invertebrate surveys;
- saltmarshes;
- fish migration routes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries ;
- contaminated land likely to lead to polluting runoff;
- vulnerable/important aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

The characterization should be conducted by a review of information currently held by competent authorities and surveys conducted or commissioned by the promoters. The surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case-specific but are likely to include surveys of water quality, river and tidal flows, groundwater levels, fisheries, aquatic biology, river corridors, recreational use, buildings, physiographic and geological features, sites and objects of archaeological or historic interest and the general landscape.

The impacts of the barrage on dynamic systems, e.g. water quality and algal growth, should be modelled where possible. Mathematical models should be produced to predict the conditions following impoundment for a variety of water quality parameters, and for any other parameters identified as a potential problem. For some parameters, models will be required for pre-barrage as well as post-barrage conditions in order to fully calibrate and validate models prior to barrage construction. The models developed should be subject to sensitivity analysis.
River flows and tidal conditions should be characterized, with consideration of extreme events (in isolation and combination) and rising sea levels. The data collated should form the basis for models to assess drainage patterns and flood risk.

Detailed geological and hydrological studies should be undertaken to ascertain baseline groundwater conditions and enable the prediction of impacts of barrage construction. Existing data should be collated and evaluated and monitoring boreholes drilled to measure groundwater levels. Test pumping may be required to evaluate aquifer properties. The location of contaminated land needs to be identified. This includes land currently or previously used in connection with activities such as coal, gas manufacture, landfill sites, chemical production and heavy industry. Monitoring around these sites will be required particularly in association with staged increase in impoundment water levels.

The levels of fish stocks and their exploitation should be assessed. The normal patterns of migration of migratory stocks should be established before impoundment.

Detailed surveys of affected habitats should be conducted to identify the distribution and abundance of aquatic and riparian species affected by the construction and operation of the barrage. The national rarity of the species found should be assessed.

## 8. Monitoring and audit

Monitoring data should be provided to the NRA's specification, with the design of monitoring programmes being relevant to predicted impacts and any remedial or mitigation works. For example, the monitoring of groundwater levels and quality associated with a staged increase in water levels may be required, along with more long-term monitoring. Water quality within an impoundment should be regularly monitored, with automatic monitoring installed for some parameters, particularly dissolved oxygen. Water levels should be continuously monitored both within the impoundment and in rivers upstream to aid flood control procedures. The migration pattern and abundance of migratory fish stocks should be monitored following impoundment.

## 9. General guidance

It should be stressed that the NRA will require that the responsibilities of the management of the barrage and impoundment are clearly defined (and adequately financed) for all stages, i.e. before, during and after construction.

### References and further guidance

Clare, R. (1992) *Tidal Power: Trends & Developments*. Thomas Telford, London.

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Jones, F.H. (1994) Barrage developments in the Welsh Region: the role of the National Rivers Authority in protecting the aquatic environment. *Journal of the {Institution of Water and Environmental Management*, **8** N°4, 432-439.

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Severn Tidal Power Group (with UK Department of Energy and CEGB) (1989) *The Severn Barrage Project*. HMSO Energy Paper N° 57.

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FISH FARMS

## 1. Introduction

This guidance note seeks to identify the potential impacts of fish farms upon the water environment. It is intended to act as a fairly detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of fish farm schemes. The NRA has particular interests in fish farm projects due to its responsibilities for fisheries, water quality, water resources and consenting The NRA are statutory consultees for developments for the purposes of fish farming. Environmental studies are likely to be necessary because, as a minimum, certain information will be required by the NRA before issuing relevant licences etc. The responsibility for such studies lies with developer and the results should be presented in an appropriate manner to address the questions raised by the NRA.

Early consultation with the NRA is recommended to enable the identification of environmental constraints and sensitive areas, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Proper justification will be required for any conclusions and access may be required to the raw data to examine particular issues in more detail.

## 2. Development Control

Fish farms may be either land-based or offshore developments. Land-based developments (and cages in freshwater lakes) require planning permission within the Town and Country Planning framework. Offshore farms do not require planning permission as such, but a licence granted by the Crown Estate Commissioners, who manage the sea bed below the low water mark, is required for the installation of fish or shellfish rearing facilities.

Crayfish farming is likely to be the subject of increasing regulation, particularly with respect to the control of escapement of non-native farmed species and the containment of disease (see Section 5.4). MAFF controls place restrictions on the permitted locality of crayfish farms, which require licences from MAFF. Crayfish farms are banned in rivers where native crayfish predominate. This is in connection with recent EC legislation, which requires the establishment of protected areas for the native crayfish *Austropotamobius pallipes*.

## 3. Environmental Assessment

For land-based salmon farming, an EA may be required under SI 1988 N° 1199 The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988. "Salmon hatchery" and "installation for the rearing of salmon" are listed on Schedule 2, i.e. those projects which "are likely to have significant effects on the environment by virtue of factors such as their nature, size or location". A Department of the Environment/Welsh Office circular (DoE 15/88, WO 23/88) and guidance (DoE/WO 1989) suggests a threshold of annual production of 100 tonnes of fish a year, below which an EA should not normally be required. However, the significance of a project will depend very much on its location and an EA may well be necessary at lower production levels and where future expansion is planned.

Trout, char, coarse fish, crayfish and other land-based "fish" farming activities may be exempt from EA requirements as only salmon are specified in the regulations. However, environmental information may be required by those considering the application and the NRA would strongly recommend an EA.

Offshore fish farm developments are subject to the Environmental Assessment (Salmon Farming in Marine Waters) Regulations 1988 (SI N° 1218), under which the Crown Estate Commissioners will consider an environmental statement from the developer, and comments from consultees and the public, before granting a lease where the development may have significant environmental effects.

## 4. NRA licences

In order to operate a fish farm, a combination of the following licences and consents will be required from the NRA.

i. **Discharge consent** - for discharges to inland and coastal surface waters. This includes discharges from caged fish farms.

ii. **Abstraction/impounding licence** - the Water Act 1989 removed the agricultural exemption for all abstractions in excess of $20m^3$/day. A licence is also required for impounding.

iii. **Land drainage consent** - will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission to discharge must be obtained prior to operation.

## 5. Major Potential impacts

The high water quality requirements of fish farms often results in their siting on sensitive watercourses and in sensitive areas, thus amplifying their potential effects upon the environment. Impacts will occur largely in operation, but construction activity such as the excavation of ponds, installation of tanks, raceways, screens and other farm construction may have a variety of impacts, including land take, pollution of watercourses, disturbance of sensitive species and damage to archaeological interests. Further NRA guidance should be referred to for the impacts of general construction activity.

The following sections concentrate on operational impacts.

### 5.1 Water quality

Fish farm activities may affect a variety of water quality determinands. The NRA will impose a discharge consent to adequately protect receiving water courses. Key aspects of water quality that may be affected by fish farms include levels of nutrients, oxygen, ammonia, other chemicals and temperature.

**Nutrient enrichment** - The leaching of inorganic nutrients from solid wastes and soluble nitrogenous fish excretion may cause eutrophication of receiving waters. Resulting algal blooms can be toxic to fish, and may be unsightly. Phosphorus is usually the nutrient limiting algal (and other plant) production in freshwaters, and nitrogen in marine waters. Other than causing algal blooms, nutrient enrichment may lead to changes in macrophyte communities, with excessive growth of some species. Nutrient-stimulated algal and plant growth may affect dissolved oxygen levels through respiration and decay.

**Oxygen depletion** - Direct oxygen depletion will be caused by fish respiration. Indirect depletion will result from the degradation of inorganic and organic wastes (which combine to give a biochemical oxygen demand or BOD). Low oxygen levels in the fish farm and receiving waters may result in the death of fish and other aquatic life.

**Ammonia** - Ammonia may result from excretion by fish, or the breakdown of waste products. High ammonia levels may be toxic to aquatic life, particularly fish. In addition, ammonia may also contribute to eutrophication, where nitrogen is the limiting nutrient.

**Suspended solids** - Solids may arise from waste food, faeces and disturbance of pond/tank sediments. High levels of suspended solids may cause direct damage to aquatic life, indirect damage through light attenuation, and may have an adverse aesthetic impact. Settlement of solids may cause smothering effects and change the nature of sediments. Settlement of solids may reduce the survival of eggs of gravel spawning fish, such as salmon and trout in streams, and whitefish (e.g. vendace) in lakes. The decay of solids may lead to low oxygen conditions in the sediment and overlying water, affecting benthic organisms and leading to the release of certain chemicals, including nutrients. Sediments may act as a significant source of nutrients in eutrophication.

**Temperature** - The temperature of fish farm effluent may be at variance with that of receiving waters, and have sublethal impacts as a result. Growth rates and the duration of embryonic development may be altered.

**Other chemicals** - There are three principal sources of chemical pollution from aquaculture:

- components of fish foods which are not assimilated by the fish;
- chemicals used for disease prevention or for the treatment of fish; and
- disinfectants and chemicals used as antifoulants.

The use of antibiotics, malachite green, formaldehyde and (in the marine context) treatments containing dichlorvos (e.g. Nuvan, Aquaguard) is of concern. Recently, the unapproved use of ivermectin has also been of particular concern.

**Disease organisms** - Disease and parasitic organisms may pass out from the fish farm with the discharge and infect wild populations. The spread of crayfish plague from crayfish farms to native stocks is a particular concern. The burial of diseased or other carcasses may be a source of further infection and contaminate groundwater with bacteria and organic material.

### 5.2 Water resources

Although the use of water by fish farms is generally non-consumptive, i.e. the volume of water from a river abstracted closely matches that discharged, there may be a section of river between intake and discharge affected by a reduced flow. The abstraction licence granted in association with a fish farm may contain a residual flow condition in order to protect the reach of river between abstraction and discharge points. In addition, the cumulative effects of several fish farms in a catchment may limit the available resource to other users. Where fish farms use groundwater supplies, abstraction may be a contentious issue, with the possible impact of falls in water table level.

### 5.3 Conservation and wildlife

A variety of impacts on conservation and wildlife may occur as a result of water quality changes as indicated above. For example: a loss of aquatic plant diversity may result from nutrient enrichment favouring faster growing aquatic plant species; eutrophication and algal growths may lead to adverse conditions for a variety of species; chemicals, temperature changes, ammonia, reduced dissolved oxygen and smothering may all affect aquatic fauna. Low flows between intake and discharge points create unfavourable conditions. In addition, disturbance of natural habitat and predator control methods may affect mammal and bird populations.

### 5.4 Fisheries

In addition to the effects on fisheries arising from changes in water quality, there may be the following impacts.

**Escaped fish** - Fish escaping from fish farms pose a threat to wild populations via competition for food and breeding sites, predation, genetic contamination and the transfer of disease. Escaped fish may be less valued by anglers than more natural stocks as escapees may be non-indigenous species such as rainbow trout and/or easier to catch, and thus angling quality may be reduced.

Similarly, crayfish escaping into the wild may become established, upsetting existing ecosystems and competing with (and predating upon) the indigenous and legally protected native crayfish, *A. pallipes*. In addition, non-native species (particularly signal crayfish, *Pastifastacus leniusculus*) can carry crayfish plague, a disease which has decimated many wild crayfish populations. It is now an offence under Section 9 of the Wildlife and Countryside Act 1981 to release, or allow to escape, three non-native species, the signal, noble (*Astacus astacus*) and narrow-clawed or Turkish (*Astacus leptodactylus*) crayfish. Non-native crayfish may also be a nuisance to anglers, the crayfish taking bait before target (fish) species, and cause damage to river/canal banks.

**Depleted or diverted flow** - Abstraction from a river may result in a significantly depleted flow, which may present a barrier to migrating fish, render sites unsuitable for spawning and may exacerbate water quality problems. The use of a weir to divert flow into the farm may present a further barrier to fish migrating upstream. Diversion of water from a river through a fish farm with insufficient screening can have serious implications for native fish, particularly smolts migrating downstream through the farm.

### 5.5 Recreation and amenity

Aesthetic effects may arise from the visual impact of fish farm buildings on the banks of scenic rivers, reduction in water quality, and eutrophication. Fresh and marine water cages will similarly have a visual impact and may hinder sailing and other water sports, and may also occupy prime anchorage sites. Reductions in river flow may affect recreation and navigation on some rivers.

The quality of angling may be affected by impacts on native stocks and the presence of escapees.

## 6. Mitigation measures

There are many technological innovations which can be used to minimize the environmental impacts of aquaculture. At the design stage, the basic design criteria can be adapted to be more sensitive to the environment. For instance, dual drainage arrangements can be incorporated to allow therapeutic/other chemical treatment processes to be isolated from the main effluents and held for separate treatment etc. During operations, technological waste control measures may be incorporated. The timing of fish migration should be considered when planning the operating regime of a fish farm. Fish farmers should follow the Codes of Practice from the British Trout Association, which was agreed with the NRA and contains more detailed mitigation measures.

### 6.1 Basic design criteria

The distance between intake and discharge should be minimized so that as little river habitat as possible is subjected to reduced flow.

The adoption of multiple outlets should be avoided so as to reduce the monitoring workload.

To reduce the risk of entrapment of migrating fish, the following are recommended:

- intakes should not be located close to impounding structures as salmonids and cyprinids aggregate immediately up or downstream of such structures;
- screens of small aperture should be installed and maintained on inlet and outlet channels; and
- where possible, inlet channels should incorporate an unobstructed route back to the river.

Solomon (1992) provides guidance on the design of screens for intakes and outfalls.
Ponds, tanks or cages should be suitably designed and adequately screened to prevent the escape of fish. Crayfish are particularly adept at escaping and suitable measures should be adopted, such using smooth surfaced materials for pond walls, having the water supply falling through pipes and fencing with overhanging tips. There should be no direct outfall to watercourses. In general, specialist advice should be sought.The design of cages, tanks and ponds should be ensure adequate protection from predators (e.g. netting) and thus obviate the temptation to use more drastic (and generally illegal) control measures.

Angling and other recreational facilities may be provided at the fish farm.

### 6.2 Waste minimization

Food pellets with lower settling velocities should be used, where appropriate, to give fish more time to consume the food before it settles out as waste. Fish should not be over fed. In addition, pellets with a reduced phosphorus content should be used to reduce the risk of eutrophication of freshwaters.

Settling devices (e.g. settling ponds, swirl concentrators and triangle filters) should be used to reduce concentrations of solids in suspension. The cleaning out of ponds and other control devices should be done with care to avoid discharges of high suspended solid loads. The disposal of solids should be by an approved method. Where space provides, reed bed treatment may be considered to remove solids and nutrients, and potentially add to the conservation value of the site.

Filtration using a gravel substrate may remove ammonia. Widespread use of recirculation in conjunction with biological filtration of the final effluent will produce a cleaner effluent and reduce water demand. Farms using heated water may reduce the risk of environmental damage by using heat conservation methods and heat exchangers.

### 6.3 Operational aspects

Farms should be stocked with fish and crayfish from parasite and disease-free sources. The use of sterile fish (triploids) is the only sure way to prevent genetic contamination or the introduction of non-indigenous species, although the adoption of vandal proof screens would ameliorate the problem. Restocking should involve fish derived from local gene pools.

The use of cleaner wrasse should be considered as an alternative to chemical treatment to prevent sea lice. Where chemicals are used (e.g. Nuvan), treatment should be restricted to enclosed treatment baths or incorporation into fish diets.

The timing of operations should be phased such that peak water demand (and hence risk of entrapment) avoid periods of the peak movement of migratory fish.

Fish carcasses and other wastes should be safely disposed of, away from watercourses. Composting using recent technologies should be considered.

## 7. Baseline surveys

Detailed information is likely to be required to determine the impact of the fish farm upon the aquatic environment. The following surveys are likely to be recommended (depending on the sensitivity of the location).

### i) Land-based farms

- river corridor survey including information on local statutory/non-statutory conservation sites and species
- sediment and water quality assessment

- benthic assessment of flora, fauna and physical features
- monitoring of flow rates and dispersion potential of the river
- fish population surveys
- aquatic invertebrate survey.

### ii) Caged units

- current modelling
- ecological survey

Details of baseline survey work should be discussed with the NRA as soon as possible as parameters are likely to be diurnally and seasonally variable.

## 8. Monitoring and audit

An appropriate monitoring strategy should be developed on the basis of baseline information and potential impacts. Fish farm operators should monitor discharges for compliance with consent conditions (as will be practiced by the NRA) and to assess the performance of fish farm design and treatment processes. There will be a requirement for the abstractor to measure the volume of water taken.

## 9. General guidance and references

There should be a limit to the number of fish farms on any stretch of river. Cumulative effects, if more than one farm is present, should be taken into consideration.

Serious consideration should be given to prohibiting further development in salt or freshwater bodies with a low dispersion potential and/or limited flushing.

The nature of pollutants in discharges from land-based farms and the formal controls exercised by the NRA are described in more detail in . Effluent treatment options are discussed in Cripps and Kelly (1994). Marine fish farms occur more frequently in Scotland. The Crown Estate Commissioners have produced guidance (CEC 1989) on the siting and design of marine fish farms in Scotland, and an updated document is expected from the Scottish Office. The Crown Estate Commissioners have also commissioned a report (Cobham Resource Consultants 1987) along with a number of other bodies into the environmental impacts, particularly landscape effects, in Scotland.

Cobham Resource Consultants (1987) *An Environmental Assessment of Fish Farms*. Countryside Commission for Scotland/Crown Estate Commissioners/Highlands and Islands Development Board/Scottish Salmon Growers' Association.

Cripps, S.J. and Kelly, L.A. (1994) Effluent treatment to meet discharge consents. In *Proceedings of the British Trout Farming Conference*, Sparsholt 1994, ed. S. Leonard. Sparsholt College, Hampshire.

Crown Estate Commissioners (1989) *Marine Fish Farming in Scotland. Guidelines on siting procedures and principles*. Crown Estate, Edinburgh.

Department of the Environment/Welsh Office (1989) *Environmental Assessment. A guide to procedures*. HMSO, London.

Edmunds (1994) In *Proceedings of the British Trout Farming Conference*, Sparsholt 1994, ed. S. Leonard. Sparsholt College, Hampshire.

Institute of Aquaculture (1990) *Fish Farming and the Scottish Freshwater Environment*. Nature Conservancy Council, Edinburgh.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls*. NRA R&D Report 1, HMSO, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF PIPELINES

## 1. Introduction

This guidance note seeks to identify the potential impacts of pipelines upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the environmental impacts of pipeline schemes. The potential impacts of pipelines are of interest to the NRA because of the authority's general environmental responsibilities. Early consultation with the NRA, particularly on the proposed routing of the pipeline will help to identify any environmental constraints and sensitive areas which may or should be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Examples of sensitive areas include river corridors of high ecological or amenity value, sites of archaeological interest, upland areas of catchments with particular sensitivities, and areas in which the groundwater is vulnerable to contamination (the principles of aquifer vulnerability are outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992). Locations in which pipeline construction could add to pollution risk include contaminated land, waste disposal areas, etc.

Legislation may require that a Environmental Assessment is carried out for proposed pipelines. The responsibility for this assessment lies with the developer. It is advantageous to conduct the EA in advance of the design phase to enable proper consideration of alternatives. The EA's conclusions, generally presented in an Environmental Statement (ES) require proper justification and the raw data should be accessible. Where an EA is not necessarily required, the NRA may still require certain environmental information in connection with NRA licences or consents.

The Department of Trade and Industry have published comprehensive guidelines for the environmental assessment of cross-country pipelines (DTI 1992) which are generally relevant to most pipeline schemes, but are particularly targeted at schemes falling under the Pipe-lines Act 1962. This note also predominantly deals with overland pipelines; a guidance note on long sea outfalls should be referred to for guidance on offshore pipelines.

## 2. Development control

The planning and construction of pipelines fall under the Town and Country Planning framework with the construction of some pipelines being permitted development under the Town and Country Planning (General Permitted Development) Order 1995. Pipeline construction may also come under a number of Acts, such as:

- The Pipe-line Act 1962 - various cross-country and local pipelines, e.g. oil pipelines;
- Land Power (Defence) Act 1958 - Government pipelines;
- Factories Act 1961 - factory pipelines;
- Mines and Quarries Act 1954 - mine and quarry pipelines;
- Gas Act 1986 - gas pipelines; and
- Water Industry Act 1991 - water pipelines and sewers.

## 3. Environmental Assessment

Under the EC Directive 85/337/EEC "oil and gas pipeline installations" are listed as Annex II projects requiring Environmental Assessment when significant environmental impacts are anticipated. These requirements are set out in The Electricity and Pipe-line Works 1990 (Assessment of Environmental Effect) Regulations (SI. 1190 442). Under these Regulations the Secretary of State decides the need for an Environmental Assessment. Water pipelines, as long distance aqueducts, are also Annex II projects and may require EA the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI No. 1199). Guidance on the need for EA for long distance aqueducts in the context of permitted development is given in Department of the Environment Circular 3/95 (Welsh Office 12/95).

In instances where there is not be a statutory requirement for EA, it may represent the most efficient process by which to take into account expected environmental impacts.

## 4. NRA licences

The NRA are the licensing body for a variety of licences and consents.

i. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

ii. **Discharge consent** - for discharges to "controlled waters", i.e. groundwaters, inland and coastal surface waters. Therefore, consent may be required for the disposal of runoff and the discharge of water from dewatering operations and that used in pipe testing or sterilization. Consents apply to both direct and indirect (i.e. after treatment) discharges to a watercourse.

iii. **Abstraction licence** - may be required for any pumping or lowering of the water table.

With respect to pipelines, land drainage consents are likely to be the most relevant. These must be obtained in advance of any construction, regardless of whether planning permission has been granted.

## 5. Major/potential impacts upon the aquatic environment

In most cases, the majority of potential impacts will occur in the construction, rather than during operational use of a pipeline. Exceptions will be where major leakage and/or pipeline failure occurs, potentially causing serious long-term impacts.

### 5.1 Construction impacts

Construction impacts will include those arising from the preparation of the working (pipeline and access) areas, trench digging and the general operation of machinery and vehicles. Impacts may be particularly significant at river crossings.

**Preparation of the working area and excavation of the pipeline trench** - This may result in damage to the site flora from direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. There may be a loss of bank stability from bankside operations. Fauna may be affected that are dependent on trees and other vegetation, e.g. birds and bats may utilize trees as nesting or roosting sites. Bankside trees may also be used as habitat by otters and may also provide shade for rivers; tree loss may result in significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction, vegetation losses and channelling of water through trenches may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation. Dewatering of excavated trenches may lead to localized lowering of the water table, affecting wetland sites and localized water resources. The discharge of water from dewatering operations may lead to direct pollution of watercourses. Runoff and soil disturbance may lead to soil erosion with subsequent pollution from raised levels of suspended solids, decreasing water quality. Pollution by suspended material may have effects on sensitive aquatic life from abrasion or more rapid attenuation of light in turbid water. In addition, sedimentation in rivers may affect substrate characteristics for aquatic flora and fauna, and reduce the quality of gravels for fish spawning, particularly trout and salmon. Reduced fish stocks will affect angling opportunities for such stocks. Angling, recreation and navigation may also be impaired by construction activities, e.g. at river banksides and crossings.

**Machinery and vehicles** - The general operation of machinery and vehicles may contribute to problems of soil compaction and soil instability. Leaking or spilled fuel and oil from stores, vehicles or machinery may contaminate both groundwater and surface waters.

**River crossings** - At river crossings the use of machinery on the river bed itself or banks may result in the loss of aquatic flora and fauna from physical damage and also through water pollution such as high concentrations of suspended sediments (with subsequent sedimentation) and from oil or fuel spills. The use of construction materials such as cement near to watercourses may also lead to pollution. Machinery and construction materials in the watercourse may also represent a barrier to migrating fish. Temporary structures and machinery in the river channel may also cause changes to flow patterns, leading to changes to channel geomorphology and loss of river substrates.

General construction activity may disturb aquatic wildlife disrupting feeding and/or reproduction. Recreational use of watercourses, angling and navigation may be particularly affected by disruption and loss of access at river crossings.

Certain archaeological features, e.g. those arising from ancient fords, mills and bridges, may be particularly threatened by river crossings.

### 5.2 End state/Operational impacts

End state impacts will arise from the routing of the pipeline, maintenance requirements and from any failure and leakage from the pipeline. The general ecological impacts from construction itself will usually be fairly temporary.

**Pipeline routing** - Where the pipeline crosses a river bed pipeline structure and other alterations to the stream bed may increase hydraulic roughness or otherwise increase flood risk. Again, changes to flow patterns may lead to changes in channel geomorphology, leading to upstream deposition and siltation, disturbance to bed form (i.e. pools, riffles etc.), loss of habitat and decreased channel stability.

Pipelines crossing over and above a river will generally be very noticeable, affecting amenity/landscape value; they may also increase flood risk and possibly affect navigation and angling interests. Overground pipelines, particularly along watercourses will have further visual impacts and will develop a localized flora along the pipeline route.

Pipeline passing underground may affect movement of groundwater, possibly blocking flow across the pipeline and channelling flow along it. Where the pipeline channels flow, it may act as a drain, thus dewatering wetlands and other habitats dependent on water table levels.

**Pipeline maintenance** - The installation of access provisions to the pipeline may result in the permanent loss of habitat along the access route. The use of access may have occasional impacts of disturbance to wildlife, trampling of plants etc. The use of herbicides, both in construction and routine maintenance may lead to pollution of groundwater or surface waters.

**Pipeline failure** - Depending on the substance carried, extent and location of failure, a pipeline failure causing leakage may cause significant pollution of groundwater and /or surface waters, with corresponding effects on water resources, losses of invertebrates, plants and fish, angling, recreation and amenity etc.

## 6. Mitigation measures

Careful planning and design, combined with the use of sympathetic construction techniques and reinstatement, can generally minimize the environmental impacts of pipelines. Routing and other mitigation measures are discussed below.

**Routing** - Alternative routing of pipelines should be considered (particularly to avoid sensitive areas) with respect to acceptability on environmental grounds. For instance, the NRA will object to oil pipelines for the strategic transfer of hydrocarbons in areas with more vulnerable aquifers. The siting of access roads, storage tanks and waste disposal facilities used during construction should also be considered. At an early stage in the planning process land-use mapping should be carried out, including identification of architectural, Sites of Special Scientific Interest (SSSIs) and other nature conservation sites. This will enable timely re-routing, or early consideration of suitable mitigation measures should re-routing not be feasible, whilst the project is still at an desk study stage - thus avoiding costly alterations and/or delays later.

The NRA will be particularly interested in the following factors in the choice of pipeline route:

- watercourses;
- aquifer vulnerability and proximity to potable supplies;

- areas of archaeological or cultural interest in the floodplain;
- areas of (aquatic) conservation interest; and
- areas of landscape or amenity importance in the floodplain.

The depth of pipelines may also be an important factor. Pipelines in contact with groundwater (e.g. at or below the water table) may directly affect groundwater quality. Also, pipeline material may degrade more rapidly from such contact, e.g. through corrosion.

The DTI (1992) discuss the wider variety of factors which may need to be considered when designing and choosing a route for a pipeline (such as development plans, population density, topography, geology, buildings, roads, railways, and other pipelines).

**Damage to plants and habitats** - Damage to plants and wildlife habitats can be minimized by restricting the working width of pipelaying operations, trenches, access roads etc. Damaged habitats should be restored to their former soil profiles and reseeded (using seeds from the original, disturbed vegetation or vegetative fragments). Grazing animals should be excluded during restoration. Reinstatement of wetlands is complex and therefore early consultation with the NRA is recommended so that the best available and practical methods are employed. Alongside rivers the NRA may seek opportunities to design in habitat enhancement.

The need for felling of mature trees should be avoided by route planning and tunnelling under such trees.

General disturbance to wildlife will be reduced by the carefully timing of operations. Appropriate phasing and timing of construction work to avoid sensitive times will reduce the environmental impacts. The most appropriate timing will depend on the wildlife at risk. A sensitive time for many bird populations will be the breeding season in spring/summer. For others, winter concentrations of migratory birds may be the sensitive period. Trout and salmon spawn in the autumn, but coarse fish in the spring/summer. Extensive maintenance works should also avoid sensitive periods.

Noise should be minimized by careful selection and use of machinery and also by the use of baffles or screens, where appropriate. Dust generation should also be minimized, particularly near sensitive vegetation and watercourses.

**River crossings** - River crossings should not be made immediately upstream of abstraction points or ecologically sensitive waters to avoid damage from construction or from pipeline failure. Non-invasive methods (e.g. thrust boring) are preferred. (The increased cost of the thrust boring technique is offset by the decreased risk of pollution, increased speed of operation and reduced likelihood of weather impacting). The fluming of rivers and streams may avoid interruption of the watercourse and may help to minimize the occurrence of suspended solids. Disturbance of river beds and banks should be minimized and care taken with the handling of cement and concrete near watercourses.

Care should also be taken when crossing other linear habitats, such as hedges and ditches, which may act as wildlife corridors in a similar manner to rivers.

**Access** - Access routes to construct the pipeline should be via suitable existing roads, where possible. Where new access routes are required these should generally be temporary, avoid riparian zones, minimize erosion and if necessary use appropriate construction materials. Special provisions may be required where habitats need to be protected. For example, if a wetland needs to be crossed, bog mats could be employed. Where unavoidable, culverts should be designed so as not to disrupt fish movement. Disruption to public accessibility should be mitigated for by the construction of gates, bridges or stiles, or arrangements for alternative access to be made. Disruption should avoid peak periods of recreational activity, e.g. angling, navigation.

**Soils** - Topsoil and subsoil should be carefully removed and stored separately so that reinstatement of soils can be carried out properly. Stockpiles should be protected (e.g. covered with sheeting) to minimize silt runoff and settlement facilities may be required for such runoff. Subsoil may need to be ripped prior to the spreading of topsoil. Compaction, may be reduced by restricting traffic movement and the use of protective boarding and low ground pressure machinery. Compaction may be reduced by minimizing operations in wet periods and winter. working on wet soils. Mixing unlike soil materials should be avoided. Permanent disposal of spoil, when required, should be off-site.

Operations close to rivers should be properly engineered to avoid affecting the stability and long term performance of river banks and flood defences.

**Storage of on-site equipment** - On-site equipment and materials including fuel and oil, should be carefully stored. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Drip trays should be placed under stationary machinery to collect oil and grease. NRA Pollution Prevention Guidelines give detailed advice on the design of storage facilities.

**Site and trench drainage** - Drains from access routes and construction areas should be designed to drain road areas only and to discharge to buffer areas (areas of land around watercourses that are unaffected directly by the development) where drainage water is likely to contain high sediment loads. Oil separators (interceptors), silt traps, wet balancing ponds, open ditches, and the use of coagulants should be also be considered, where appropriate, to reduce water quality impacts. Soakaways may be useful, although NRA guidance should be sought on design as their use as they may increase groundwater quality impacts. If necessary, header drains should be used and water stops installed in trenches. Stops will certainly be required to prevent the course of the completed pipeline acting as a drain and thus dewatering wetlands.

**Field drains and ditches** - These should be identified and carefully reinstated to prevent flooding and maintain the character of the landscape.

**Archaeological sites and sites of other interest** - These should be preserved *in situ*, where feasible, with the provision of facilities for visitors if appropriate. Relocation should be considered where damage is unavoidable.

**Pesticides** - The use of pesticides should follow relevant guidance, e.g. NRA (1995) for the use of herbicides near watercourses.

**Pipeline testing** - Testing requirements should be carefully considered, particularly with respect to the times, points and rates that water can be drawn off or discharged for hydrostatic testing. Due to the higher risk of failure during precommissioning testing, no pipeline should be tested with liquid product - water should be used (if appropriate). Approval to dispose of test water is normally required from the NRA, particularly if inhibitors or biocides have been added to the test water.

**Pipeline failure** - Pipelines should be adequately designed, operated and monitored such that there is only a remote risk of failure. Emergency arrangements, including notification of the NRA, should be prepared for the unlikely event should it happen. Pipeline failure could have adverse effects on the surface or groundwater particularly if carrying hazardous materials it is therefore prudent for routes to avoid sensitive aquatic habitats and aquifer recharge zones. If air patrols are used for monitoring markers should be positioned to aid route location and the aircraft should fly at a sufficient height to minimize disturbance to wildlife.

## 7. Baseline surveys

Field surveys should be appropriate with respect to timing, timescale and methods used and preferably include surveys at the same time of the season as the proposed construction, in the year prior to the works.

Field surveys should be sufficient to:

- establish the pre-construction (baseline) state of the site;
- aid the identification of construction practices with the least environmental risk;
- determine the best operational conditions for the aquatic environment during construction, such as water level in wetlands, water flow in rivers and allowable sediment load or deoxygenation effects on river biota especially fish;
- provide a basis for immediate and informed advice when critical environmental factors arise during construction; and
- optimize the reinstatement of channels or wetland areas by the appropriate choice or extent of use of a specific technique.

The surveys required are site specific but are likely to include physical, chemical, and morphological data on water, soils and topographic features in addition to the species and numbers of the major organisms present. Important indicator species include flowering plants, dragonflies, amphibians, reptiles and native and migrant birds. The presence and habitats of rare species should particularly be identified. Information on fisheries, recreational use archaeology and the river corridor as a whole will also need to be collected.

## 8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

## 9. References

Department of Trade and Industry (1992) *Guidelines for the Environmental Assessment of Cross-country Pipelines. HMSO, London.*

NRA (1992) *Policy and practice for the protection of groundwater.* HMSO, London.

Wilkinson, H. (1995) *Environmental, Planning and Land Registration Issues Explained ... Pipes, Mains, Cables and Sewers*, Pearson Professional Ltd, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF SEA OUTFALL PROJECTS

## 1. Introduction

This guidance note seeks to identify the potential impacts of long sea outfalls upon the water environment. It is intended to form the basis of a fairly detailed scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of long sea outfall schemes. The NRA has an interest in such projects in relation to its duties primarily with respect to water quality but also with respect to amenity, recreation, conservation, fisheries and flood defence. To be able to adequately comment on such schemes the NRA would need at least certain environmental information and preferably a full EA, which the local planning authority may require under planning legislation. The responsibility for the assessment lies with the promoter/developer of the scheme. Any conclusions from such an assessment may require proper justification and raw data should be accessible. There are distinct advantages to conduct an EA in advance with a proper consideration of alternative treatment/disposal options and outfall routes. Early
NRA involvement will enable the identification of environmental constraints and the avoidance of sensitive areas, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

Outfalls may be used for the disposal of a variety of wastes including sewage effluents and industrial discharges. A variety of literature on outfalls is available, particularly with respect to sewage discharges. Nixon (1990) provided an assessment of the environmental effects of long sea outfalls based on the findings of a detailed study by Cooper and Thompson (1989) on two outfalls discharging domestic waste. The studies concluded that discharges from a properly designed outfall should have a negligible effect on the environment. Environmentally sensitive outfall design was considered by Neville-Jones and
Dorling (1986). Some of the construction issues are also discussed by CIRIA (1994).

## 2. Development control

Development control of headworks and outfall structures will generally fall under two different statutes. The Town and Country Planning framework applies only to development above Mean Low Water. Under the Food and Environmental Protection Act (FEPA) licences are required from the Ministry of Agriculture, Fisheries and Food (MAFF) or the Welsh Office) for work below Mean High Water Spring.

The construction of long sea outfalls may require an environmental assessment under the terms of SI 1988/1199, The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988, if the outfall is considered as part of a waste water treatment plant, e.g. where there are significant headworks. In addition, long sea outfalls may require consent from the Ministry of Transport under the Coast Protection Act 1949.

NRA is a statutory consultee for developments involving sewage, slurry or sludge treatment or disposal.

## 3. NRA licences

A discharge consent is required for the discharge of effluents to coastal waters. Permission to discharge must be obtained prior to operation of the outfall.

## 4. Major/Potential impacts

Impacts may occur in both the construction and operation of the outfall. In addition the decommission of the structure may require consideration.

### 4.1 Construction impacts

#### 4.1.1 Water quality

Construction operations, including dewatering, may lead to disturbance of sediments and runoff leading to localized high sediment loads. Oil, fuel, cement and chemicals used in construction may cause localized water and sediment pollution. In addition, there may be the mobilization of other chemicals from contaminated land or sediments into site drainage water or directly to the sea.

#### 4.1.2 Amenity and Recreation

The construction works may cause visual and obstructive disturbance to the amenity and recreational use of a site, particularly beaches and associated waters. Noise from pile driving, pumps and vehicular movements may also disturb users. Severance of amenity resources may occur across the course of the outfall.

#### 4.1.3 Conservation

The course of the pipe laying works and access roads may pass through sites of conservation interest, such as sand dunes, saltmarshes and bird roosting or feeding sites. There may be direct damage of such sites or disturbance through noise and intrusion. Compaction of coastal margins by heavy machinery may lead to a loss in soil stability and structure and increased rates of erosion.

#### 4.1.4 Fisheries

Construction operations may interfere with commercial shellfisheries, netting or potting activities and recreational angling.

#### 4.1.5 Flood defence.

There may be a requirement to temporarily breach coastal defences during construction with an associated loss of protection.

## 4.2 End state/Operational impacts

### 4.2.1 Water quality

The receiving waters of the discharge will be the subject of Surface Water Quality Objectives with associated Environmental or Water Quality Standards which the NRA will require to be maintained at all times. More rigorous standards will be applied to waters designated as bathing beaches (under the EC Directive on bathing water quality 76/160/EEC), shell fisheries (under the EC Directive on the quality required shellfish waters 79/923/EEC) and 'sensitive' waters (under the EC Urban Waste Water Treatment Directive 91/271/EEC). Particularly where the outfall is designed to receive industrial discharges, standards may be applied with respect to compliance with the Dangerous Substances Directive (76/464/EEC) and the Titanium Dioxide Directive (78/176/EEC).

For sewage, the major parameters of concern are likely to include the following.

i. **Bacteria and viruses** - Sewage effluents contain a high level of microbial contamination of potential risk to human health. The viability of commercial shellfisheries may be affected by microbial contamination.

ii. **Solids** - Faecal solids, grease balls, condoms and sanitary towels in a discharge represent potential aesthetic, amenity and health risk problems. These and other 'litter' items may also represent a hazard to wildlife. A localized build up of solids in the vicinity of the outfall may alter the benthic community.

iii. **Dissolved oxygen demand** - Sewage discharges generally have a high biochemical oxygen demand and may thus cause a depression in dissolved oxygen levels in the receiving waters with implications for benthic and pelagic organisms.

iv. **Ammonia** - Sewage discharges generally contain high concentrations of ammonia with implications for benthic and pelagic organisms. Ammonia also contributes to nutrient loads.

v. **Nutrients** - In the marine environment nitrogen (often measured as total inorganic nitrogen) is usually the nutrient limiting algal and other plant growth and the principal cause of marine eutrophication. Algal blooms may have aesthetic, toxic and other water quality effects.

vi. **Heavy metals and organics** - Sewage discharges may contain elevated concentrations of heavy metals and organic chemicals, depending on the 'catchment' of the discharge. These may have implications for benthic and pelagic organisms either directly or through sediment and bioaccumulation pathways.

vii. **Other contaminants** - there may be elevated concentrations of other contaminants (e.g. oil) depending on the 'catchment' of the discharge. Again, these may have implications for benthic and pelagic organisms. Where disinfection of discharges occurs, residual products may arise which may themselves have water quality impacts.

For outfalls receiving storm sewage the nature of the discharge will be related to flow and recent weather conditions, and the catchment of the discharge. For industrial outfalls the parameters of concern will relate to the particular industries.

### 4.2.2 Amenity

The outfall may be visually obtrusive where its structure and or associated buildings such as pumping stations are above ground level. Pumping operations may cause noise disturbance. Solids originating from the discharge will have an obvious detrimental impact.

### 4.2.3 Recreation

Bacterial and aesthetic water quality may potentially limit recreational activity. In addition, the completed outfall structure may potentially represent a hazard to water users if exposed from the sediment. Exposed pipelines running across beaches may also cause severance of the beach.

### 4.2.4 Conservation

The discharge may affect the ecology of the receiving waters through physical smothering by settling solids and other water quality impacts. In addition, the ecology may be affected by localized changes to substrates (including the outfall structure) and flow patterns.

### 4.2.5 Fisheries

The discharge could potentially alter the quality of fish and shellfish through water quality effects. However, under Asset Management Plan 2 (AMP2) guidance a discharge should not alter the existing classification under the Shellfish Hygiene Directive.

### 4.3 Decommission

The outfall may have a relatively limited design life (40-50 years). The subsequently fate of the pipeline should be considered as it may continue to represent an obstructive hazard.

## 5. Mitigation measures

The NRA may require certain mitigation measures to reduce the impact of the scheme. These may be subject to certain timing constraints.

- **Water quality** - The suitable siting and design of outfalls for adequate dispersion should reduce the impacts of microbial and other contamination on water quality and inshore use. The survival of microbial organisms generally reduced by prolonged exposure to light and sea water. Bacterial contamination may also be reduced by disinfection, although the impact of the disinfection process should be considered. Solids may be reduced by suitable primary treatment and screening in the head works.

- **Amenity** - The construction operation should be restricted to a time of low beach use, e.g. outside of the summer months. Visual intrusion and severance should be reduced by laying the pipeline below the ground surface as much as possible. The use of screens and treatment of storm sewage to remove solids will reduce litter and other aesthetic impacts on amenity.

- **Recreation** - Construction operations should be concentrated at times of low beach use (although outside of the such periods weather conditions may hamper construction works. Collision and other snagging hazards should be reduced by laying the pipeline below the beach surface.

- **Conservation** - The construction operation should endeavour to minimize or avoid noise, vehicular movements and other forms of disturbance during seasons and/or times of the day when affected sites are important for bird roosting or feeding.

- **Fisheries** - Water quality standards should be adequate to have a minimal impact on fisheries. Pipelines should be laid below the beach surface to reduce the snagging of nets and other fishing gear.

- **Flood defence** - The breaching of coastal defences should be of a minimal duration and conducted at a time of low flood risk, e.g. neap tides in summer.

## 6. Baseline surveys

Early consultation with the NRA (and others) and a literature review should identify sensitive areas such as important bathing areas, shell fisheries, fisheries and 'sensitive' waters under the terms of the Urban Waste Water Treatment Directive (UWWTD). Such exercises will also identify the less sensitive High Natural Dispersion Areas under the UWWTD. The NRA should provide the promoter of the outfall with details of data held by the Authority. The NRA will generally insist on further baseline information and surveys, with requirements specified with respect to timescales and recommended methods. Tidal patterns should be identified by tracer studies, use of drogues etc. There should be modelling of tidal flow dispersion. Sediments should be characterized in the proximity of the discharge and along dispersion routes. Ecological studies should be carried out to characterize the ecology along the course of pipeline, in the vicinity of the discharge and along dispersion routes. Seasonal and diurnal bird counts may be required.

Surveys undertaken should include:

- assessment and modelling of input budgets and loadings;
- hydrographic surveys and the assessment of tidal patterns;
- bathymetric surveys;
- assessment of meteorological data;
- dispersion surveys and modelling of tidal flow dispersion;
- characterization of sediments in the proximity of the discharge and along dispersion routes; and
- ecological surveys along the course of pipeline, in the vicinity of the discharge and along dispersion routes.

## 7. Monitoring and audit

Monitoring should be conducted to assess the impacts of the outfall, both from the discharge itself and from outfall construction. Such monitoring should be relevant to predicted impacts and any mitigation works.

## 8. References

The number and volume of outfall discharges in a given area will be limited by the assimilation capacity of the receiving waters.

Cooper, V.A. and Thompson, M.J. (1989) Effects of sea outfalls on the environment. Foundation for Water Research. Report N° FR 0031.

Construction Industry Research and Information Association (1994) *Environmental Assessment*.Special Publication 96. CIRIA, London.

Neville-Jones, P.J.D. and Dorling, C. (1986) Outfall design guide for environmental protection. WRc Report N° ER209E.

Nixon S.C. (1990) Effects of sea outfalls on the environment - executive summary report. Foundation for Water Research Report N° FR 0093.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF POINTS OF LARGE ABSTRACTION

## 1. Introduction

This guidance note seeks to identify the potential impacts of large abstraction points upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA) in the environmental assessment or appraisal of proposed large abstractions. The NRA has an interest in abstraction proposals due not only to its responsibilities for water resources and as a licensing body, but also due to responsibilities for water quality, fisheries, conservation, navigation and recreation. In order to comment on applications for abstraction licences the NRA will usually require an environmental report (ER) with information from environmental studies on the potential impacts of abstraction. Responsibility for these studies lies with developer. The ER may be in the form of an Environmental Statement. The conclusions of the ER will require proper justification and if required the raw data upon which these are based should be accessible.

Informal discussions with the NRA prior to environmental studies and licence application will ensure that the ER addresses the NRA concerns. Early contact will also enable the identification of environmental factors constraining permissible abstraction and mitigation measures that may be appropriate.

## 2. Development control

The construction at abstraction points of pump houses, boreholes etc. may require planning permission under the Town and Country Planning Framework. Abstraction points are not subject to formal Environmental Assessment (EA) in connection with planning applications, although environmental information may be required by local planning authorities. However, formal EA may be required for associated schemes, such as reservoirs, as set out in government guidance (e.g. DoE/WO 1989).

## 3. NRA licences

Under the terms of the Water Resources Act 1991, an abstraction licence is required from the NRA for all significant abstractions. Where abstraction is combined within impoundment of a watercourse an impoundment licence is also required. Guidance on abstraction licensing may be found in the NRA leaflet *Abstraction Licensing and Water Resources*.

Section 32 consents will be required in advance of groundwater abstraction, to authorize the construction and test pumping of boreholes, wells or any other works intended for abstracting water (see NRA leaflet *Searching for groundwater*).

The NRA is also the body responsible for:

**land drainage consents** - required for any works on the bed and banks of a river or construction of any structure likely to impede the flow (e.g. pump houses on a riverbank); and

**discharge consents** - for discharges to inland surface and groundwaters, and to coastal waters. Non-consumptive use of abstracted water may result in a discharge subject to consent.

Consent is also required for the introduction of fish to impoundments.

## 4. Major potential impacts

### 4.1 Construction impacts

The construction of boreholes, intakes and pump houses may cause localized damage to soil and vegetation in the area of construction and access roads. Bankside activities may lead to bank instability and erosion. The use of construction materials, e.g. cement, may pollute waters. Pollution may arise from leakage from machinery, on-site fuel and chemical stores, latrines and slurry lagoons.

Drilling may affect groundwater quality and drilling fluids or cutting may cause pollution of surface waters if discharged. Also, discharges of "clean" water from test pumping of boreholes may have impacts, primarily on the hydrology of receiving streams.

Impacts arising from the construction of impoundments are discussed in separate guidance (on reservoirs).

### 4.2 Impacts of operation/abstraction

The major impacts of abstraction upon the aquatic environment may relate to direct effects on groundwater and surface waters from their abstraction resulting in reduction in groundwater levels and river flows respectively. More indirect effects may also occur, for example groundwater abstraction may lead to reduced flows in spring-fed streams.

**Water supply** - Abstraction can potentially affect the availability of water for other users. These may include others with the 'protected right' to abstract water themselves. New abstraction may affect the availability and derogate from existing abstraction rights.

**Water quality** - Due to the lack of river flow, and hence mixing and dilution of pollution, there may be a relative increase in the impacts of pollution. The problems of pollution may be exacerbated by reduced aeration in less turbulent river flows and higher summer water temperatures. The NRA will be anxious that changes in the concentration of pollutants, dissolved oxygen and water temperature do not compromise Environmental Quality Standards, ascribed to the watercourse or water body. Reduced flows and higher concentration of plant nutrients, particularly phosphates, may result in prolific plant and algal growth. Aside from effects on aesthetic and ecological quality, such growths may alter water quality through changes in pH, biochemical oxygen demand (BOD) and dissolved oxygen levels. Raised pH levels during periods of intense photosynthesis may affect the toxicity of chemicals such as ammonia. Algae may also produce toxins under certain conditions.

Reduced river flow in tidal areas may result in the increase penetration upstream of saline water, affecting water quality and river/estuarine ecology. Similarly, groundwater abstraction in coastal areas may result in saline intrusion into aquifers. Likewise, abstraction of groundwaters in the vicinity of contaminated land may draw in pollutants water.

**Fisheries** - Fish habitat may be affected by reductions in river flow itself and by reductions in the depth and wetted width of rivers. In shallower water, fish will be particularly vulnerable to predation, angling and poaching. Fish may also be stranded by sudden changes in water depth due to intermittent abstraction. Reductions in water quality may seriously affect fish survival. In addition, fish may be more vulnerable to parasites and disease. Reduced river or estuarine flows may act as a barrier to fish migration, thus preventing access to both spawning grounds and exploitation by anglers upstream. Also, where headwater areas of streams are particularly important spawning and nursery areas, direct abstraction or abstraction of connected groundwaters may affect the survival of fish eggs laid in gravels from dewatering and reduced through-gravel flow. Gravels may also be affected by increased siltation rates arising from reduced river flow.

**Aquatic ecology** - Aquatic life other than fish may also be affected by changes in water quality, depth, and wetted width. Whilst algae and some plants may benefit from low flow conditions other species of plant and fauna may be affected by blankets of weed covering the river bottom, reducing the quality of the substrate, or blooms of planktonic forms affecting water quality. Reductions in water quality including may also affect dogs and livestock that may drinking the water. Whilst predators such as kingfishers and otters may benefit from the increased vulnerability of prey, this will not be sustainable in the long term.

Fish and other aquatic life may suffer from entrainment at the point of abstraction.

The noise and vibration of pumps may disturb wildlife (and other river users).

Wetlands and other riparian habitats may be affected by reduced water table levels arising from groundwater abstraction (and, more rarely, reduced river flow). Many wetland and riparian species require wet conditions created by a high water table. Agricultural production may also be affected.

**Navigation, recreation and amenity** - Significant reductions in river flow may affect navigation, there being insufficient depth of water for the passage of boats. The amount of water in locks may constitute a substantial element of river flow. Other recreational use of waterways may be affected by reduced flows, e.g. canoeing and angling. Water quality deterioration, e.g. algal blooms, may create unpleasant conditions for water-based recreation.

The amenity value of rivers or lakes may be affected by abstraction, due to the reduced flow itself and the increased visibility of pollution, algal and plant growths. Severely reduced water depth may result in extensive areas of exposed substrate that may be unsightly. The total absence of flow in spring-fed systems will seriously affect the amenity value of these systems and the landscape. Construction and operation of abstraction devices and pumps may affect amenity use.

**Heritage and archaeology** - Reductions in groundwater levels may affect the foundations of buildings of archaeological or other heritage interest.

**River geomorphology** - Increased river flows and altered flow regimes may result in altered geomorphology of watercourses, arising from altered sedimentation and erosion patterns.

## 5. Mitigation measures

The proposed abstraction should avoid sensitive areas such as:

- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- contaminated land; and
- upland areas of catchments with particular sensitivities.

Ideally, new developments with high abstraction demands should be planned for areas where water supplies are more plentiful and abstraction is less likely to have serious impacts on supplies.

Also, impacts may be reduced by avoiding unnecessary abstraction and restricting abstraction to certain times of year, e.g. wetter winter months, thus avoiding periods of natural low flow. The impacts of abstractions in tidal areas may be reduced by restricting abstraction to certain states of the tide. Where seasonal restrictions are imposed or desirable, the construction and use of storage areas may reduce water demands in more sensitive periods.

Alternative sources of water from less sensitive areas may be available for use to compensate for abstraction or to provide an alternative supply. However, compensation flows from alternative sources may have impacts relating to the mixing of different types and the transfer of species.

Impacts from groundwater abstraction on wetland areas may be reduced by pumping water directly onto key wetland areas to raise flows and water levels.

During construction of intakes, pump houses etc., chemicals, fuel and oil should be suitably stored in areas away from watercourses with adequate bunding should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken handling cement or pouring concrete near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects. Site sewerage and waste disposal arrangements should be adequately considered. Boreholes should be constructed with suitable casings, grouting, and plugging (as necessary) to avoid contamination of groundwaters.

Abstraction points should be adequately screened (physically) to minimize losses of fish and other life through impingement and entrainment. Systems employing warning stimuli from air bubbles, light, electricity, water velocity and pressure changes may be appropriate to reduce fish losses. Solomon (1992) discusses intake designs in more detail.

## 6. Baseline information

To ascertain the impact of abstractions baseline information on the following surveys may be required using approved methods and timing:

- groundwater resources (including hydrogeology);
- surface water resources (including hydrology);
- water quality;
- river corridor surveys - wildlife conservation;
- fisheries;
- aquatic biology;
- landscape/amenity;
- recreation;
- modelling of tidal/river flow; and
- geomorphology.

Some of the information may be available from the NRA and other sources. However, surveys may be required to gather the remaining information. The NRA will generally not release information on existing rights, which will be used along with the ER to decide on the application.

## 7. Monitoring

Monitoring of volumes abstracted may be a condition of the licence. Other monitoring, relevant to the predicted impacts and remedial/mitigation works, may be recommended.

## 8. References

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Drake, P.J. and Sherriff, J.D. F. (1987) A method for managing river abstractions and protecting the environment. *Journal of Water and Environmental Management*, 27-38.

National Rivers Authority (1994) *Abstraction Licensing and Water Resources. A brief guide for potential abstractors*. NRA, Bristol.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls*. NRA R&D Report 1. HMSO, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF POINTS OF LARGE DISCHARGE

## 1. Introduction

This guidance note seeks to identify the potential impacts of large discharge points upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA) in the environmental assessment or appraisal of proposed large discharges. The NRA has an interest in discharge proposals due not only to its responsibilities for water quality and as a licensing body, but also due to responsibilities for water resources, fisheries, conservation, navigation and recreation. In order to comment on consent applications for large discharges the NRA will usually require an environmental report (ER) with information from environmental studies on the potential impacts of the discharge. Responsibility for these studies lies with developer. The ER may take the form of an Environmental Statement. The conclusions of the ER will require proper justification and if required the raw data upon which these are based should be accessible.

Informal discussions with the NRA prior to environmental studies and applications for consent will ensure that the ER addresses NRA concerns. Early contact will also enable the identification of environmental factors constraining permissible discharge and mitigation measures that may be appropriate.

Separate guidance to this note is available on long sea outfalls.

## 2. Development control

The construction of associated infrastructure pump houses; outfalls etc. may require planning permission under the Town and Country Planning Framework. Discharge points are generally not subject to formal Environmental Assessment (EA) in connection with planning applications, although environmental information may be required by local planning authorities. However, formal EA may be required for developments that are the source of the discharge. Indeed, government guidance (DoE/WO 1989) on assessing the need for EA in certain developments, includes a criterion on discharges, i.e. "whether the project is likely to give rise to particularly complex or adverse effects, for example, in terms of the discharge of pollutants".

Under the Food and Environmental Protection Act (FEPA) licences are required from the Ministry of Agriculture, Fisheries and Food (MAFF) or the Welsh Office) for work below Mean High Water Spring.

## 3. NRA licences

A discharge consent will be required from the NRA for discharges of sewage or trade effluent to "controlled waters" (i.e. inland surface waters, coastal waters and groundwaters). The NRA's approach to consenting discharges is set out in the report *Discharges Consents and Compliance - the NRA's approach to control of discharges to water* (NRA 1994).

The NRA is also the body responsible for:

**land drainage consents** - required for any works on the bed and banks of a river or construction of any structure likely to impede the flow; and

**abstraction/impoundment licences** - for abstracting or impounding waters.

Discharges from certain industries or "prescribed processes" under Integrated Pollution Control will require consent from Her Majesty's Inspectorate of Pollution (HMIP) under the terms of the Environmental Protection Act 1990.

## 4. Major potential impacts

### 4.1 Construction impacts

The construction of outfalls and pump houses may cause localized damage to soil and vegetation in the area of construction and access roads. Bankside activities may lead to bank instability and erosion. The use of construction materials, e.g. cement, may pollute waters. Pollution may arise from leakage from machinery, on-site fuel and chemical stores and latrines.

### 4.2 Impacts of operation/discharge

The major impacts of discharges upon the aquatic environment will include and stem from changes in the quality and levels or flow of groundwater and surface waters. Large discharges will primarily be point discharges to surface waters. Therefore this note does not discuss diffuse discharges and those to land.

**Water quality** - The potential impacts of a discharge on the quality of the receiving water will be related to the relative quality and volume/flow of the discharge to the receiving water. The NRA will ensure, through its consenting procedures, that the discharge does not adversely affect water quality and damage the environment.

A major potential impact on water quality is that water quality objectives ascribed to a watercourse or water body potential may be compromised if water is polluted by a discharge and becomes unfit for certain uses, e.g. drinking water, recreation. Water resources and downstream users may also be affected by pollution. Also, of major concern will be the ecological impacts of pollutants. Some of the impacts of specific types of pollutants are indicated below.

**Plant nutrients** such as phosphates and nitrates may cause eutrophication and the prolific growth of algal and plants. Algal blooms may be particularly problematic, as they may produce toxins and other chemicals affecting water quality, unsightly scums may form, other species may be outcompeted by the algae, and the collapse of blooms may lead to deoxygenation of water through algal decay. Intense photosynthetic activity from plants and algae can change the chemical nature of the water through pH and associated effects.

**Organic material** is characterized by a high BOD (Biochemical Oxygen Demand), organic pollution can have a serious deoxygenating effect, thus potentially harming fish and other life.

Sewage effluents typically contain organic material, ammonia and suspended solids.

**Ammonia** may be directly toxic, particularly to fish, and have a deoxygenating effect from its chemical transition to nitrate. Increased nitrate levels may stimulate plant and algal growth.

**Suspended solids** can have a direct effect from abrasion and smothering. Indirect effects include reduced visibility of prey, increased attenuation of light and reduced plant growth, and alteration of substrate characteristics through sedimentation. Sedimentation within gravels used by salmon and trout may affect the survival of eggs and therefore fisheries.

**Acidity/alkalinity** is measured as pH. This can have direct effects on life or more indirect through changing water chemistry. The toxicity of certain chemicals, e.g. ammonia and aluminium, may be strongly influenced by pH levels.

**Cyanide** is very toxic to fish and other aquatic life.

**Metals** such as cadmium and zinc may be toxic to aquatic life. Metals may persist in the environment by accumulating within organisms in food chains (bioaccumulation) and in sediments.

**Pesticides** are particularly toxic to target and related species or species groups. Pesticides, particularly organochlorines, may be particularly persistent and bioaccumulate within foodchains

**Thermal discharges** may be lethal due to temperature changes raising the ambient temperature above the limits that are tolerated by particular organisms. Indirect effects may occur through changes in water chemistry and stratification of water bodies.

Changes to aquatic life may affect other organisms, e.g. otters and kingfishers may be seriously affected by the loss or contamination of fish.

**Water flow** - Large discharges may substantially increase river flow and generally alter the flow regime/hydrology of receiving waters. This may have direct effects on river ecology, with a switch to more flow tolerant species. Shallow water habitats may be lost. Raised water levels may affect riparian flora and fauna. Changes in water table level may arise, altering adjacent land use (e.g. agriculture) and wetlands.

Sediment transport patterns may change leading to changed substrate quality and general river geomorphology.

Increased flow in rivers may reduce the penetration of saline water into estuaries, thus affecting estuarine ecology.
Migratory fish may alter their behaviour as a result of flow changes. Fish may also be attracted to the points of discharge and attempt to enter discharge outlets.

**Flood defence** - Increased water depth and flow may cause downstream areas to have an increased risk and frequency of flooding.

**Amenity** - The colour, flow, odour and presence of litter and other debris may be aesthetically displeasing and reduce the amenity value of a receiving water.

**Recreation** - Changes in flow, and the presence of bacteria, litter, algal growth may compromise recreational use, e.g. water contact sports may be particularly unpleasant or banned by health authorities in polluted waters. Changes in water depth, flow and fish species may affect angling quality.

**Navigation** - Increased water depth may benefit navigation and particularly canoeing.

**Heritage and archaeology** - Raised groundwater levels may affect the foundations of buildings of archaeological or other historic interest. The discharge may cause visual disturbance.

**River geomorphology** - Increased river flows and altered flow regimes may result in altered geomorphology of watercourses, arising from altered sedimentation and erosion patterns.

## 5. Mitigation measures

The proposed discharge should avoid sensitive areas such as:

- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable (or potentially valuable) fisheries; and
- upland areas of catchments with particular sensitivities.

The impacts on water quality may be reduced by improved treatment before discharge, e.g. by using treatment works, settling lagoons, reed beds etc.

The impacts of water flow may be mitigated by reducing the volume of discharges, by utilizing on-site recycling systems and flow regulation of intermittent discharges using balancing lagoons.

Discharge outlets should be designed so as to discourage the entry of migratory fish. Solomon (1992) has produced some relevant guidance.

During construction of discharge outfalls, pump houses etc., chemicals, fuel and oil should be suitably stored in areas away from watercourses with adequate bunding. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken handling cement or pouring concrete near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects. Site sewerage and waste disposal arrangements should be adequately considered.

## 6. Baseline information

To ascertain the impact of large discharges, baseline information on the following may be required using approved methods and timing:

- water quality;
- water resources;
- hydrology;
- river corridor surveys - wildlife conservation;
- fisheries;
- aquatic biology;
- amenity/landscape;
- recreation; and
- geomorphology.

Some of the information may be available from the NRA and other sources. However, surveys may be required to gather the remaining information.

## 7. Monitoring

Monitoring of the rate and quality of the discharge may be a condition of the consent. Other monitoring, relevant to the predicted impacts and remedial/mitigation work, may be recommended. .

## 8. References and general guidance

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide*. HMSO, London.

Fraser, J.C. (1972) *Regulated discharge and the stream environment*. In: Oglesby *et al.* (eds) *River Ecology and Man*, pp263-286. Academic Press, New York.

Hawkes, F.B. (1974) Heated discharges from thermal power stations. *Effluent Water Treatment Journal*, 14 No.10, 549-559.

National Rivers Authority (1994) *Discharges Consents and Compliance - the NRA's approach to control of discharges to water*. Water Quality Series No. 17. HMSO, London.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls*. NRA R&D Report 1. HMSO, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF SEWAGE TREATMENT WORKS (EXTENSION AND INSTALLATION)

## 1. Introduction

This guidance note seeks to identify the potential impacts of sewage treatment works (STWs) upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of STW schemes. The NRA has an interest in STWs, particularly due to potential impacts on water quality, water resources, flood defence, fisheries and conservation.

EA may be formally required for new STWs. Where EA is not formally required, it may still be a useful process to convey environmental information to interested parties such as the NRA. The responsibility for obtaining information and/or environmental assessment lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of the proposed development, such that environmental constraints can be identified and avoided and appropriate mitigation can be designed into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives.

Other NRA guidance notes have been produced for various other development types, and may be relevant, particularly those on general construction, points of large discharge, sea outfalls, waste disposal facilities and pipelines. In addition, guidance on the NRA's approach to the aspect of discharge consents (NRA 1994) may be useful.

## 2. Development control

Development control of STWs will be through the Town and Country Planning system. Under the recently consolidated General Development Order, the NRA are statutory consultees for development relating to the sewage treatment or disposal and development for sludge disposal.

## 3. Environmental Assessment

Local Planning Authorities will require EA for proposed STWs where significant impacts are expected as STWs are Schedule 2 projects under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199). Schedule 2 includes "a waste water treatment plant" under which most STWs may be expected to fall. Sludge disposal may also require separate EA, "a site for sludge deposition" being a further category under Schedule 2. Guidance on the need for EA for STWs in the context of permitted development is provided by Department of the Environment Circular 3/95 (Welsh Office 12/95).

## 4. NRA licences

It will be necessary to obtain the following authorizations from the NRA:

- **discharge consent** - for discharges to inland surface and coastal waters, and groundwaters; and
- **land drainage consent** - for any works on the bed and banks of a river or construction of any

structure likely to impede the flow.

The NRA may also require abstraction and impounding licences where these are applicable. Breaches of licence or consent conditions and pollution of surface and groundwaters may result in criminal proceedings.

## 5. Major potential impacts

Primarily the NRA will be concerned about impacts affecting water quality, water resources, flood defence, fisheries, aquatic biology, conservation, recreation and amenity. In general, it will be necessary to demonstrate that none of the water quality objectives applied to watercourses are adversely affected during construction and operation of the plant. Impacts may arise from the construction of the works and associated infrastructure and in their operation.

### 5.1 Construction impacts

The guidance note on the impacts of general construction should be referred to as many of the issues arising in the construction phase of a new STW or the extension of an existing one are broadly the same as for other construction works. The construction of a STW will generally consist of inlet works connecting to the collecting sewerage system, screens, tanks for settlement and treatment, treatment systems, outfalls, sludge storage and treatment areas, and pumping stations. The laying of associated infrastructure such as power and water supply will generally also be required.

**Land take** - The general destruction of habitats and displacement or loss of species will result from land take.

**Preparation of the working area and construction of buildings, roads and tanks** - Site flora and fauna may be damaged through direct damage and through compaction and other physical disruption of the soil. The disposal of excavated soil may extend the area affected. Fauna that are dependent on trees and other vegetation may be affected, e.g. birds and bats may use trees as nesting or roosting sites. Bankside trees may also be used by otters and may also provide shade for rivers; tree loss may result in significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation. Runoff and soil disturbance may lead to increased soil erosion with an associated increase in sediment load to rivers. High concentrations of suspended solids loadings reduce water quality with direct impacts on flora and fauna and the aesthetic appearance of a watercourse. In addition, sedimentation of solids will affect substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation, reducing egg survival.

**Machinery and vehicles** - The general operation of machinery and vehicles may contribute to problems of soil compaction and stability. Leaking or spilled fuel and oil from vehicles, machinery or storage areas may contaminate both groundwater and surface waters

**River outfall** - The use of machinery on the river bed or banks may result in a loss in bankside stability, and the loss of aquatic flora and fauna from physical damage. Losses may also result from water pollution, e.g. suspended solids and oil. The use of construction materials such as cement and concrete near to watercourses may also lead to pollution. Machinery and construction materials in the watercourse may represent a barrier to navigation and migrating fish, and may result in the loss of (recreational) access to the river. Flow patterns may be altered, leading to changes in channel geomorphology and loss of river substrates.

**Coastal STWs and outfalls** - Compared to inland works, coastal STWs connected to long sea outfalls may provide more limited treatment (e.g. screening and primary settlement) and be the headworks for the outfall. Construction of coastal STWs, headworks and outfalls may damage coastal habitats and disrupt recreational use, among other impacts (see guidance on long sea outfalls).

**Pipe laying** - New STWs and extensions to existing works may require new sewerage pipelines which is a permitted development not requiring planning permission (and EA). However, there may be impacts and reference should be made to separate guidance on pipelines for extensive works or work in sensitive areas.

## 5.2 Operational impacts

The NRA has a declared "no deterioration" policy which enforces any new discharge proposal. The following potential impacts will be taken into account in assessing consent conditions.

**Discharge of treated effluent** - The physical flow of the discharge may result in significantly altered stream hydrology with increased river flows and velocities, potentially causing bank degradation, erosion and other geomorphological changes. The net result may be increases in channel width and average suspended sediment load. High suspended solid loadings will reduce water quality with direct impacts on flora and fauna and also on the aesthetic appearance of a watercourse. Sedimentation of solids will in turn alter substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation, reducing egg-fry survival.

The chemical characteristics of the effluent itself will reflect the nature of the sewage "catchment", i.e. the relative proportion of industrial and domestic sewage, and treatment efficacy. Typically, organic waste, ammonia, phosphates and suspended solids may be expected from domestic wastes, with increasing contamination from heavy metals etc. from industrial wastes. The water quality of the receiving water may generally be directly affected by the quality of the effluent. Potential impacts may arise from: microbial contamination; an increase in suspended solids, debris and rubbish; chemical pollution; temperature changes; deoxygenation and nutrient enrichment. The fauna and flora may be impacted by the altered water conditions and as a result of growths or blooms of sewage fungus, algae and plants. The temperature of the effluent may be different to that of the river potentially causing thermal stress, stratification and ecological changes reflecting the altered temperature regime.

Discharges to watercourses may also result in adverse odour, foaming, other nuisances, health risks and degrade facilities for water users.

If upgrading works are being carried out at a STW, the quality of the receiving water should generally improve, leading to changes in aquatic communities and potential water uses.

**Site runoff** - Runoff from buildings, car parks etc. will further alter stream hydrology, increasing flows after rainfall, and reduce infiltration to groundwater.

**Odour** - Site processes such as cleaning screens and emptying tanks may result in odours which may present a nuisance.

**Noise** - Noise and vibration caused during construction (e.g. from piling and machinery) and during operations (e.g. from pumping and sludge activation) may disturb sensitive wildlife and recreational water use.

**Visual** - The STW may have negative effects on riverine or coastal landscapes.

**Sludge disposal** - A variety of impacts may arise due to sludge disposal (e.g. to land or incinerator) and may give rise to such as contamination of groundwater and surface waters. These are discussed more widely in separate guidance on waste disposal. On-site storage, handling and treatment of sludge may also lead to contamination of groundwaters and land. Odour problems at the STW may also be exacerbated.

**Spillages and leakages** - Sludge, oil, fuel or chemicals may lead to the contamination or pollution of both groundwater and surface waters.

## 6. Mitigation measures

The location and size of developments will be key factors in determining impact significance. Where possible, construction activities should avoid sensitive areas, such as:

- flood risk areas, e.g. floodplains;
- wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting or potentially supporting valuable fisheries;
- areas of conservation importance;
- contaminated land likely to lead to polluting runoff;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The choice of treatment processes for the proposed STW will have differing impacts, but will be dependent on a number of factors including the amount of land available and the capacity of the receiving waters to take effluent discharges. The NRA's primary requirement is compliance with consent conditions. However, where available land space permits, there may be net conservation benefits to use more extensive low energy design options such as percolating filters and reed beds. These options, and reed beds in particular, provide useful habitats for birds and other wildlife. Reed beds and finishing lagoons may also be effective treatment methods, improving the quality of effluent discharged.

**Energy recovery**, e.g. from sludge recovery should be considered.

The **timing** of activities should be such that sensitive periods, such as bird nesting and fish spawning seasons, are avoided, if possible. Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant period.

Developers and their contractors should follow building regulations, codes of good practice etc., where these are applicable. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor will be employed to ensure the protection and enhancement of the environment.

**Both permanent and temporary land take** should be minimized and original habitat features maintained where possible. Opportunities to create suitable new habitat features should be considered.

**The storage and handling of soil** should be such that the area affected is minimized but the soil structure is maintained (i.e. avoid mixing topsoil with underlying material). Exposed soil/spoil mounds should be covered to reduce the runoff of silt. Imported material should be avoided as this may contain polluting substances or propagules of invasive plants that may rapidly spread through river corridors. Seeding of landscaped areas may (or may not) be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value. Opportunities to create wetland or other habitats should be considered.

**Compaction of soils** by heavy machinery should be minimized, particularly in sensitive sites, with the use of boards and other temporary supporting structures.

**Bank instability** should be mitigated by careful reinstatement of damaged parts and reinforcement of areas at risk.

**Trees** and other wildlife habitats should be retained. Opportunities should be sought to replant appropriate trees.

**In-channel work** should avoid periods of maximum disruption to relevant seasonal activities, i.e. navigation, fish spawning. Interruption to recreational access and navigation should be minimized, although public safety should not compromised. Methods of working should be used that minimize the extent of disturbance to the banks and bed of the river.

Where **culverting** is unavoidable, the bottom should be continuous with that of the natural stream to allow the uninterrupted passage of fish, and headroom should be maximized light entry and permit the passage of birds and mammals.

Adequate headroom and/or screening will also reduce flood risks

**Access roads** should avoid sensitive areas. Boards and temporary bridges may reduce soil compaction and other damage. Compounds, car parks and other areas associated with the site of construction should be carefully located to minimize any added impacts.

**Chemicals, fuel and oil** should be suitably stored in areas away from watercourses and drains with adequate bunding should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects.

**Sewage and waste disposal** arrangements should be adequately considered.

**Noise and intrusion** should be minimized and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites.

**Dust** may be dampened down to reduce aerial transmission, but should not be washed into drains etc. Vehicle (wheel) wash facilities should be constructed with adequate containment and subsequent treatment of washings.

**Runoff** from the site should be contained where it may be polluting. Oil separators (interceptors) should be considered if oil is a likely pollutant. Isolation points designed into the drainage system may be useful to prevent pollution of watercourses where there are high risks of damage from spillages.

**Outfall design** should be such so as to encourage mixing. The installation of blockstone weirs may be acceptable as an aeration aid in rivers. Discharge points should not be placed where there is a risk of stagnation.

**Back up/alarm systems** should be installed in the event of process failure.

## 7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies. Surveys should be conducted at relevant times of year using recommended methods. The findings should highlight particularly sensitive sites, habitats or species.

In general, the NRA will require information on (from surveys or otherwise):

- river corridor survey (for wildlife conservation);
- aquatic biology;
- fisheries;
- water quality;
- hydrology;
- water resources;
- hydrogeology;

- landscape/amenity;
- recreation;
- river/estuary/coastal geomorphology; and
- archaeology.

## 8. Monitoring and audit

Monitoring to assess compliance with discharge consent conditions will be carried out by the NRA. A monitoring programme relevant to assessing predicted impacts and the success of mitigation works is recommended.

Audits of site management practices during construction may ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment.

## 9. General guidance and references

Construction Industry Research and Information Association (1994) *Environmental Assessment.* Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London.

Fehr, G. ad Jurging, M. (1993) EIA of sewage treatment plants - the importance of the assessment process and its impact on the official decision. *GWF - Wasser/Abwasser*, 134, No.8, 474-481. (In German, English Summary).

National Rivers Authority (1994) Discharge Consents and Compliance: *The NRA's approach to control of discharge to water. Water* Quality Series N° 17. HMSO, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF LARGE RESIDENTIAL DEVELOPMENTS

## 1. Introduction

This guidance note seeks to identify the potential impacts of large residential and business park schemes upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of such schemes. Where an EA is not required by the planning authority, this note should also be useful for voluntary EA and other environmental studies done in connection with the development.

It is the responsibility of the developer to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Proper justification should be required for any conclusions and access may be required to the raw data to examine particular issues in more detail.

## 2. Development Control

New housing and business parks require planning permission and as such are approved by local planning authorities under procedures set out under the Town and Country Planning Act 1990. As the development comprises a number of smaller units, it is common for the concept to be approved by the issuing of outline planning permission subject to the design details being finalized at a later date. Hence, Environmental Statements (ESs) for such developments are frequently vague as a result of the rudimentary stage of project designs when they are prepared. However, it should still be possible to identify and address fundamental issues. Consultations will be necessary at a later stage to sort out details.

## 3. Environmental Assessment - The Regulations

An EA may be required for housing, business parks and other related infrastructure developments under the terms of SI 1988 N° 1199. As their potential impacts upon the water environment are broadly similar, they are considered together.

DoE Circular 15/88 (WO 23/88) divides infrastructure projects into three main types:

- industrial estate developments;
- urban development schemes; and
- other projects, e.g. holiday village or hotel complex.

It suggests threshold criteria of size where an EA may be required. These vary according to project classification.

## 4. Interpretation of the Regulations

In practice, some confusion has arisen as to which category many infrastructure developments fall under as there is clearly scope for overlap between project categories and, consequently, uncertainty as to which thresholds to apply.

In addition, the thresholds are widely accepted as being very high. Developments below the size criteria can still have a serious environmental impact. Such is the detrimental nature of some infrastructure development projects on the aquatic environment that the NRA wish to be involved in the screening of projects. This would indicate whether an EA is required.

Location is an important factor and, in line with its general environmental duties, the NRA are likely to require an EA under the following circumstances:

- where valuable river, wetland or lakeland habitats are likely to be destroyed or impoverished;
- where the development may cause a decline in water quality or a breach in water quality objectives;
- for developments likely to have significant impact upon the availability of water resources or upon groundwater quality or quantity;
- for developments in the headwaters or for developments likely to cause a significant increase in flood risk; and
- developments necessitating modification to existing sewage treatment works.

## 5. NRA Licences

Housing developments and business parks are likely to require a combination of the following licences and consents from the NRA.

i. **Discharge consent** - for "trade effluent" which is likely to be contaminated, such as water draining from large car parks, lorry loading bays, fuel storage and filling areas. Consent will also be required for treated sewage effluent to a watercourse or soakaway. Main sewerage will have to be adequate to serve the development. Discharge consents may be required for vehicle washing and other cleaning activities, e.g. cooling waters and discharge from air-conditioning and refrigeration plant. The Prohibition Notice Procedure now applies under the Water Resources Act 1991, for surface water from housing and "clean" business parks.

ii. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Local byelaws also forbid obstruction or infilling of the floodplain without consent.

iii. **Abstraction licence** - for all abstraction in excess of 20m$^3$/day. Consent is also required for test boreholes and impoundments.

iv. **Impounding licence** - for any impounding of water, e.g. the creation of artificial ponds and lakes.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission for abstraction and discharge must be obtained prior to operation.

## 6. Major Impacts

This note does not consider particular large-scale industrial developments or aspects of holiday villages/hotel complexes beyond the buildings themselves. Other guidance, e.g. on large industry and on golf courses may be appropriate. In addition, many construction issues may be covered in more detail by guidance on general construction.

Impacts on the aquatic environment may arise as a result of construction activities or due to the final development (operational). Business parks and other infrastructure developments are likely to incorporate a number of associated developments and activities. These are often neglected in EAs. Particular attention should be paid to such activities as they may have the most serious impacts upon the water environment.

The major impacts identified here relate to alteration in catchment responses to rainfall including loss of groundwater and aquifer recharge capacity; water quality and water resource implications; increased pressure on existing infrastructure (water supply and sewage disposal) and conservation and recreation issues (dependent upon the project location).

### 6.1 Associated activities

Business parks frequently comprise a number of separate developments and it is crucial not to neglect the impacts of associated developments such as:

- access roads;
- car parks;
- bridges;
- river diversions
- vehicle washing areas;
- lake infilling; and
- creation of lakes and ponds;

The impacts of some associated activities are outlined below whilst others are covered in separate guidance notes. It is important to be aware of specific impacts which result from separate activities, e.g. vehicle washing areas draining to the surface water system will be prohibited by the NRA, unless adequate treatment facilities are provided.

#### a) River diversion

A river is a dynamic system and, if disturbed, will try to regain equilibrium, leading to a change in the erosion and deposition patterns. Any physical alteration to river channels such as meander removal, regrading or river diversion will have long-term effects upon channel geomorphology, downstream flooding, flora, fauna, fisheries and landscape.

In line with its conservation duties, the NRA seeks to promote river corridors as a valuable resource and must be involved at the earliest stages in any proposed diversions.

### b) River crossings, bridges and embankments

Insensitive design or the inappropriate location of river crossings may constrict river flow, increasing flood risk. Bank instability may result from rivers undermining such structures. The NRA has a presumption against culverting, and would wish to set design criteria for river crossings, bridges and embankments so that they do not detract from the river environment or pose a flood risk.

## 6.2 Construction impacts

One or a combination of the following related construction activities may have a significant effect upon the water environment. The timing of construction relative to the bird nesting season and salmonid migration is often crucial. The following list is illustrative rather than definitive.

| | |
|---|---|
| **Activity:** | **Bankside tree removal** |
| **Impacts** | loss of bird and bat nesting/roosting sites |
| **direct** | loss of bank stability |
| | increased water temperature due to loss of shading |
| | increased light leading to algal problems |
| | loss in landscape and amenity value. |
| **Activity:** | **Stripping of topsoil and loss of surface cover** |
| **Impacts** | increased soil erosion |
| **direct** | increased sediment load in rivers |
| | altered infiltration |
| | increased runoff |
| **indirect** | effects upon aquatic flora and fauna |
| | effects upon fisheries and angling. |
| **Activity:** | **Bad practice in the disposal of spoil, chemicals and containers** |
| | **Care not taken with oil handling** |
| | **Cement poured in or near watercourses and groundwater** |
| | **Discharge of water from dewatering operations** |
| | **Work near or in operational sewers** |
| **Impacts** | pollution of watercourses and groundwater |
| **direct** | blockage of watercourses by debris leading to flooding |
| **indirect** | effects upon aquatic flora and fauna |
| | effects upon fisheries, angling and recreation. |
| **Activity:** | **Compaction of river banks by heavy machinery;** |
| **Impacts** | loss in bank stability |
| **direct** | destruction of soil structure |
| | destruction of bankside flora. |
| **Activity:** | **Noise, intrusion** |
| **Impacts** | disturbance to river fauna |
| **direct** | outward migration of sensitive species. |

| | |
|---|---|
| **Activity:** | **In-channel work** |
| **Impacts direct** | disturbance to wildlife (feeding/mating)<br>barrier to migrating fish<br>loss of access to the river (recreation)<br>loss of river substrate<br>changes to channel geomorphology<br>sediment resuspension leading to water quality problems. |

## 6.3 Operational impacts

### a) Infrastructure requirements - Third party discussions

New housing and industrial developments place an increased demand upon the existing infrastructure and efforts should be made to ensure that the appropriate facilities are available to accommodate future water supply and sewage disposal. The appropriate water supply and sewage disposal companies should be contracted to obtain this information and to provide them with sufficient time to phase any necessary projects. Combined Sewer Overflows may operate with increasing frequency causing water quality problems in receiving waters.

If new development necessitates the initiation of additional water resources projects, then the matter becomes in NRA concern. In keeping with its duties to manage water resources, the NRA would not wish developments to be occupied until a water supply source could be found which had no adverse effect on the environment.

### b) Site drainage

The site drainage characteristics are likely to change as a result of increased runoff from paved areas, roofs and drained landscaped areas which may:

- alter the catchment response to rainfall; and
- change the surface water flow characteristics.

Existing watercourses and lakes should not be subject to adverse impact from the predicted stormwater runoff. The source control measures should be applied wherever possible, including swales, infiltration systems and balancing ponds where appropriate. Such ponds should be off-line.

### c) Surface water quality implications

Surface water quality is likely to be reduced as a result of pollution from a number of disparate sources, for instance:

- contaminated road and surface runoff (salt, soil and debris);
- increased risk of spillage or pollution incidents;
- sewage disposal;
- redevelopment of any contaminated land; and
- any other consented discharge.

### d) Groundwater implications

Groundwater may be affected by reduced recharge from the surface or pollution from pollutant seepage into groundwater including that from the sources above and from incorrectly located or designed soakaways. Groundwater levels may also be affected. Attention should be paid to groundwater levels in any excavations.

### e) Flood defence

Flood defence concerns may arise as a result of the development itself either being sited in a vulnerable location with insufficient protection (e.g. on a river floodplain) or exposing other properties to an increased flood risk. This may occur as a result of reduced infiltration rates and increased surface runoff. Urbanization of a catchment will produce a more "peaky" hydrograph after a rainfall event. Thus, development in the headwaters of a catchment is likely to increase flood risk for downstream properties.

It is contrary to NRA policy to provide flood defence to facilitate new developments. However, in some cases, it may be acceptable for the developer to carry out appropriate flood protection himself, bearing in mind the need to minimize and mitigate fully any adverse environmental impacts. Source control is to be encouraged wherever possible. Agreements may be made under Section 106 of the Town and Country Planning Act 1990.

Flood defence issues are likely to arise as a result of:

- an altered catchment response to rainfall;
- developments having an effect upon the integrity of existing river or coastal defences;
- development in the floodplain, washlands or coastal areas; and
- river diversion or any blockage or impediment to flow.

### f) Conservation and wildlife

Direct loss of habitat will result if river corridors or lakes are destroyed. Increased noise and disturbance may have an effect upon wildlife as will changes in water quality. Potential disturbance of new habitats may result from increased visitor pressure and recreation activities occurring as a result of the development.

### g) Archaeology

Excavation in river floodplains or river diversions may uncover archaeological remains. Arrangements must be made to contact the County Archaeologist to establish any risk of damage and the need for the removal or preservation of any findings.

## 7. Mitigation measures

Measures which should be taken to mitigate adverse effects will have to be discussed with reference to the project in question. The NRA may issue relevant Pollution Prevention Guidelines which should be followed. Guidance on the control of highway drainage (Luker and

Montague 1994) may also be relevant. In general, the following principles apply.

**a) Drainage**

Refuse, litter and other waste should be stored in designated areas.

All storage areas should be roofed. Uncontaminated roof water should be kept separate from surface runoff and drained to a soakaway, if possible, or a watercourse.

Areas designated for handling "abnormal materials" (i.e. potentially polluting materials such as milk or pesticides) should be drained to the foul sewer via a grit trap.

Car parks should be drained to the surface water system via an adequate oil separator (interceptor) where there is a moderate to high risk of oil pollution. Operation and maintenance of such devices should be agreed in advance. (The NRA may require other surface water to be discharged via an adequate oil separator (interceptor)).

Where combined drainage systems are proposed, there should be some certification that all foul connections have been correctly made.

The NRA may require the discharge of surface water to be controlled to a "greenfield rate" by provision of attenuation ponds. These may also be designed to provide treatment where necessary.

**b) Balancing ponds**

Balancing ponds are a common mitigation measure. Balancing ponds should be off-line (instream ponds may alter stream ecology including the proliferation of algae). Such ponds can serve a variety of functions including the following:

i. **Water quality** - They may provide a primary treatment for surface runoff by allowing for the settlement of suspended solids.

ii. **Flood defence** - They may provide flood storage areas.

iii. **Groundwater Recharge** - They may provide groundwater recharge which helps to support river baseflows.

iv. **Conservation** - If suitably designed and maintained, areas of conservation and amenity value may be created. This may be limited by the level of pollution in the runoff. Biological treatment of surface runoff by reed beds should reduce pollution levels.

**c) Conservation of river corridors**

The NRA wish to promote river corridors as conservation and amenity areas. As such they are opposed to developments likely to have a significant detrimental effect on river corridors. However, in some cases, appropriate mitigation may be acceptable including measures such as the following:

- An adequate river corridor width between the development and existing or proposed river channels. This should preferably be with public access. A figure of 50 m from either bank has been widely quoted as appropriate to preserve the river continuity.

- 8 m or 9 m *minimum* (depending upon local land drainage byelaws) on each bank to be provided beneath bridges and river crossings. Local stone or brickwork should be selected to blend in with the local environment.

- If culverting is unavoidable, the length should be kept to a minimum, a freeboard above the top water level should be maintained to allow the free passage of debris. Reinstatement of the bed with a suitable substrate and maintenance of access for migratory fish and mammals should be carried out.

- Transfer of alien plant species must be avoided.

**e) Sewerage**

Sewerage and sewage treatment facilities should be adequate, and extended if necessary, so that receiving water quality is not compromised by discharges (both from sewage treatment works, outfalls and combined sewer overflows).

**f) Conservation of water resources - demand management**

Where abstraction licences are required, the NRA would wish to see efforts made to cut site losses of water. Examples include reducing leakage through cracked pipes and recycling of water within systems. Where water supply is from the mains, this matter should be discussed with the appropriate water supply company.

## 8. Baseline Information

The following information will be required:

a) a river corridor survey for any channel affected by the development;
b) the capacity of the existing infrastructure;
c) the predicted current and future demands which will be placed upon it by the development;
d) an indication of whether the private water supply and sewage disposal companies have been contacted and if and how they propose to meet this demand within an agreed timescale.

Other surveys which may be required include:
- wildlife conservation;
- aquatic biology;
- fisheries;
- geomorphology;

- recreation and amenity;
- water quality;
- hydrology and drainage;
- hydrogeology;
- archaeology; and
- landscape;

Details of baseline survey work should be discussed with the NRA as soon as possible, as parameters are likely to be diurnally and seasonally variable. Where outline planning permission is applied for, it is common for the NRA to place a holding objection upon such applications until sufficient information is supplied.

## 9. Maintenance

Facilities should be provided for access to watercourses and provisions made for regular maintenance.

## 10. Monitoring and Maintenance

An appropriate monitoring and maintenance strategy should be devised, based upon initial findings and the predicted impacts of the project. Audit may be required in certain cases.

## 11. Further guidance

Construction Industry Research and Information Association (1992) *Scope for the control of urban runoff.* Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) *Environmental Assessment.* Special Publication 96. CIRIA, London.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges.* CIRIA Report 142. Construction Industry Research and Information Association,London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF LARGE INDUSTRIAL/MANUFACTURING DEVELOPMENTS AND OPERATIONS

## 1. Introduction

This guidance note seeks to identify the potential impacts large industrial developments upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of such schemes. Other notes have also been produced for various development issues that may be relevant; these are referred to in the text. Large industrial development types covered more specifically by other guidance include a oil refineries and power stations. The NRA has an interest in large industrial developments, particularly due to potential impacts on water quality, water resources, flood defence, fisheries and conservation.

Large industrial developments, by virtue of their size alone, will generally require EA. In instances where EA is not formally required, the process remains a useful means of conveying environmental information to the NRA and other interested parties. Indeed, certain information may be required by the NRA in connection with licence/consent applications (Section 4). The responsibility for obtaining information and/or EA lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of the proposed development. It enables environmental constraints to be identified and avoided and appropriate mitigation to be designed into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives for a scheme. There should also be some consideration of strategic issues such as the availability of water resources to meet the particular development.

## 2. Development control

Industrial and manufacturing developments are generally subject to development controls within the framework of Town and Country Planning.

## 3. Environmental Assessment

Under the terms of the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI N° 1199) an EA is mandatory for project types listed in Schedule 1 of the Regulations, and would normally be required for those listed under Schedule 2 when significant impacts are expected. Relevant Schedule 1 projects include:

- integrated works for the initial melting of cast-iron and steel;
- installations for the extraction, processing or transformation of asbestos products; and
- integrated chemical installations.

Relevant Schedule 2 projects include:

- various metals processing operations;
- various chemical industries (other than those under Schedule 1);
- glass manufacture;

- textile, leather, wood and paper industries;
- rubber industry;
- industrial estates;
- manufacture of artificial mineral fibres;
- manufacture or processing of gunpowder and other explosives; and
- modifications of Schedule 1 developments.

Fuller description of development types and guidance on the significance of impacts for Schedule 2 projects has been produced by the Department of the Environment and Welsh Office (as DoE Circular 15/88 (WO Circular 23/88) and DoE/WO (1989)). For large industrial developments Schedule 2 EA may be required by virtue of size alone.

Many of the above developments will include prescribed processes requiring the application of Integrated Pollution Control (IPC) under the Environmental Protection Act 1990. These will require an assessment of Best Practicable Environmental Option (BPEO) and use of Best Available Techniques Not Entailing Excessive Costs (BATNEEC). The NRA are statutory consultees for developments involving IPC authorization (and waste disposal) and should be contacted at an early stage for such developments.

## 4. NRA authorizations

The following licences/consents may be required from the NRA in connection with the development.

i. **Discharge consent** - for discharges to "controlled waters", i.e. groundwaters, inland and coastal surface waters.

ii. **Abstraction/impounding licence** - for abstraction or impounding of water.

iii. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Discharge controls under IPC fall under the jurisdiction of Her Majesty's Inspectorate of Pollution (HMIP). The NRA are statutory consultees on the quality of such discharges to controlled waters.

## 5. Major potential impacts

Impacts will occur in both the construction and operation of industrial sites. Other guidance is available for general construction issues which may be useful in addition. Where the development consists of low impact light industry, guidance on large residential and business parks may be more applicable than this note.

In general, a major concern of the NRA will be the effects of discharges and accidental spills on water quality. It will be necessary to demonstrate that none of the water quality objectives applied to watercourses are adversely affected. Pollution of surface and groundwaters may result in criminal proceedings, as may any breaches of consent conditions.

### 5.1 Construction phase

**Land take** - Virtually all new developments involve some degree of land take. In the case of large industrial and manufacturing developments the amount of land take is likely to be considerable, resulting in the general destruction of habitats and displacement or loss of species.

**Preparation of the working area and construction of buildings, roads and plant** - Site flora and fauna may be damaged through direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation. Runoff and soil disturbance may lead to increased soil erosion with an associated increased sediment load in rivers. High suspended solid loadings reduce water quality and can have direct impacts on flora and fauna and the aesthetic appearance of a watercourse. Sedimentation of solids may, in turn, alter substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation. Imported base/infill material may cause pollution from leaching or runoff.

**Machinery and vehicles** - The general operation of machinery and vehicles may contribute to problems of soil compaction and instability. Leaking or spilled fuel and oil from machinery and vehicles whilst in use or in storage may contaminate both groundwater and surface waters.

Noise and vibration from the use of machinery and vehicles may cause habitat disturbance resulting in the loss of sensitive species from the area.

**Contaminated land** - Where the project involves the redevelopment of contaminated land, construction activities may lead to the mobilization of contaminants and pollution of groundwater and/or surface waters. Separate guidance is available on such redevelopment.

**In river works** - In or near channel work such as the construction of water intakes and waste discharge points is likely to cause disturbance to wildlife; it may also present a barrier to navigation and migrating fish, result in the loss of (recreational) access to the river, and lead to changes in the river substrate and channel geomorphology. Sediment resuspension may lead to reduced water quality and siltation downstream. Erosion and runoff may add to these loads.

**Stream diversion** - Where diversion of streams occurs there will be a loss of a section of river with its associated and long-established habitats, flora and fauna. The newly created section will initially be ecologically poor and may lack habitat features. It may also be unstable, leading to bank and bed erosion and flood defence problems.

**Culverting** - Culverting of rivers may result in shading and the loss of natural bankside and substrate along the affected section of river. This may lead to temperature changes, a loss of plants and faunal changes. The culvert may also act as a barrier to the migration of fish, birds and mammals and increase flood risk.

**Associated works** - Compounds, workers accommodation, car parks and other areas associated with the site of construction may extend the area of impact beyond that of the immediate development. Also, impacts may arise from associated infrastructure, e.g. it may be necessary to construct pipelines to and from a new industrial development for carriage of water, fuel, and/or wastes to and from the site. (Guidelines on the impacts of pipelines are available).

## 5.2 Operational impacts

Impacts arising from the operation of the completed industrial/manufacturing plant will be depend to some extent on the nature of the plant.

**Site runoff** - Runoff from the industrial site and associated storage areas, roads and car parks is likely to become contaminated with oil and fuel from vehicles and operations. Runoff may also become contaminated with metals, chemical, organic matter etc. depending on the type of industrial process. Runoff may cause a deterioration of surface and/or groundwater quality.

**Discharge of effluents** - Effluents which are discharged from the site will result in increased river flows and velocities which may cause bank degradation and erosion. The net result may be alterations in channel width suspended sediment loads and deposition/erosion patterns.

Water quality may be decreased by the addition of the effluent; microbial contamination, increases in debris/rubbish, chemical pollution, deoxygenation and/or eutrophication may occur. The temperature of the effluent may be different to that of the river and may exacerbate impacts of other pollution; thermal stratification may also occur. The fauna and flora may be impacted by the altered water conditions, algal blooms may form in nutrient-rich, low flow conditions.

Separate guidance is available on the impacts of large discharges.

**Emissions** - Atmospheric emissions may lead to local deposition of contaminants and may give rise to acidification of more distant freshwater systems in soft water areas with a low buffering capacity, causing damaging effects on the water quality of receiving waters and their communities. Low pH in itself can be acutely toxic to fish and but effects are more usually associated with pH-related changes in aluminium toxicity. Acid-stressed systems may show reduced densities and diversity of aquatic fauna, including fish.

**Abstraction of water** - Water abstraction may be necessary. The severity of impacts will depend on the location and volumes extracted. Abstraction this will cause an altered hydrography, including a lowered water table and reduced flows. In addition, the stream's mixing and dilution capacity will be decreased. The lower flows may cause changes in stream morphology due to increased sedimentation downstream and physicochemical properties of the water may alter due to the reduced volume. If too great a proportion of flow is abstracted, the lack of water may present a significant barrier to fish migration and movement, thereby affecting breeding success, feeding etc. Secondary effects may be exerted on other water users, e.g. fishermen. The effects of abstraction are likely to be most severe during low flow conditions. The aquatic community may be altered due to the change in habitat and physicochemical properties.

**Spillages and leakages** - Bad practice or a lack of care in a variety of construction and operational activities may cause pollution of watercourses. Examples of such activities include: the disposal of chemicals and containers, oil handling and storage, the pouring of cement near watercourses, the discharge of water from dewatering operations, site sewerage and work near, or on, operational sewers. Chemical or organic pollution may affect aquatic flora and fauna directly or indirectly through a lack of food. The loss of fish may reduce angling success. Downstream water resources may be jeopardized as may other uses, e.g. recreation. The aesthetic appearance of the watercourse may be reduced. Direct blockage of watercourses may arise from various debris and lead to flooding.

**Site management** - The use of pesticides and/or fertilizers on the site may result in the contamination of surface and/or groundwaters potentially resulting in a deterioration in quality and loss of aquatic life.

## 6. Mitigation measures

The location and size of developments will be key factors in determining impact significance. Where possible, construction activities should avoid sensitive areas, such as:

- flood risk areas, e.g. floodplains;
- wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- areas of conservation importance;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The careful timing of activities may avoid sensitive periods, e.g. bird nesting and fish spawning seasons.

**Construction practices** - Building regulations, codes of good practice, NRA guidance etc. should be followed where appropriate. Staff, including supervisors, should be made aware of the risks of site activities to the environment.

**Permanent and temporary land take** - Land take should be minimized and original habitat features maintained. Compounds, car parks and other areas associated with the site of construction should be carefully located to minimize additional impacts.

**Wildlife habitats** - Important habitats should be retained. In addition, opportunities should be sought to create new habitats, particularly ones similar to those lost in the development. Where feasible, soils, sediment, plants etc. should be transferred to the new habitats, including movement of such material to the course of diverted channels.

Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant period.

**The storage and handling of soil** - The area affected should be minimized and the soil structure maintained, i.e. avoid mixing topsoil with underlying material. Stored and other exposed soil or spoil should be covered to minimize silt runoff. Imported material should be avoided as this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value.

**Compaction of soils** - The use of boards and other temporary supporting structures and restricting the movement of vehicles and machinery in wet conditions will minimize compaction by heavy machinery.

**Chemicals, fuel and oil** - Suitably storage areas away from watercourses and drains should be used, with adequate bunding should spillage occur. Drip trays should also be utilized with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects. Sewerage and waste disposal arrangements should be adequately considered.

**Drainage** - Temporary drainage during construction and more permanent drainage following completion should incorporate facilities such as storage tanks, oil separators (interceptors), silt traps and wet balancing ponds, as appropriate, to reduce water quality impacts of runoff and spillages. Field drains and ditches should be identified and carefully reinstated to prevent flooding and to maintain the character of the landscape. Flood compensation measures should be incorporated where the flood plain is affected; these should be designed in consultation with the NRA.

**Site runoff** - The use of permeable membranes, floating roads, pervious gabions, may reduced site runoff, although they should not be used if there is a high risk of contamination from through flow. The discharge of runoff may be regulated by passage through balancing ponds/retention basins. These may also act as a buffer against poor water quality from storm runoff, as sediment traps, and provide useful aquatic and wetland habitats. Other drainage facilities such as oil separators (interceptors) should be considered if oil is a likely pollutant. Isolation points designed into the drainage system may be useful to prevent pollution of watercourses where there are high risks of spillage. There will be a requirement for containment of fire-fighting water.

**Dust** - Dampening down of dust will reduce aerial transmission, but dampening water should not be washed into drains without sediment traps. Vehicle (wheel) wash facilities should be adequately constructed with containment of the effluent for proper treatment and disposal.

**Noise and intrusion** - Avoidance of work at sensitive times/locations, e.g. in the evenings where birds roost in adjacent sites, and the use of baffles etc. should reduce disturbance from noise and intrusion.

**In-channel work** - Peak periods of relevant seasonal activities (i.e. navigation, fish spawning) should be avoided. Interruption to recreational access and navigation should be minimized, although public safety should not compromised. Methods of working should be used that minimize the extent of disturbance to the banks and bed of the river.

**Culverting** - When unavoidable, culverts should be designed with the invert set below normal bed level to enable some bed features to reform and to allow the uninterrupted passage of fish. The headroom of the culvert should be maximized to enable light entry and permit the passage of birds and mammals. Adequate headroom and/or screening will also reduce flood risks.

**Abstraction of water** - Damage to aquatic ecosystems may be reduced by restricting abstraction to high flow conditions, or limiting the amount abstracted during low flow conditions. On-site storage reservoirs may also be useful to supplement the supply. Abstraction requirements may also be reduced by the use of recirculating or recycling systems and effective leakage controls.

**Contingency plans** - Plans to be used in the event of a major pollution incident should be set up. These should include emergency procedures on how to deal with the pollution. Where appropriate, booms should available. Such emergency equipment should be stored so that it is readily accessible and maintained in good condition. Staff should be trained regularly on deployment methods so that in the event of an emergency deployment is rapid and effective. Dispersants should only be used on spills only when absolutely necessary; and where possible, use should be restricted to those which are known to have the lowest toxicity. Fire fighting plans should be such that the risks of flushing contaminants into water systems are minimal.

**Management systems** - Operational impacts may be reduced by the formulation, adoption and adherence to environmental management systems (e.g. to comply with BS7750).

## 7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies. Surveys should be conducted at relevant times of year using recommended methods. The findings should highlight particularly sensitive sites, habitats or species.
In general, the NRA will require information on (from surveys or otherwise):

- river corridor survey (for wildlife conservation);
- fisheries;
- aquatic biology;
- water quality;
- water resources;
- hydrology and hydrogeology;
- landscape/amenity;
- recreation;
- river geomorphology; and
- archaeology.

## 8. Monitoring and audit

A relevant monitoring programme is recommended to assess the predicted impacts and the success mitigation works.

Audits of site management practices during construction may ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment. Audits should also be carried out on operational practices.

## 9. General guidance and references

Construction Industry Research and Information Association (1992) *Scope for the control of urban runoff.* Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) *Environmental Assessment.* Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures.* HMSO, London

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide.* HMSO, London.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land contamination & Reclamation,* 1 No. 4, 197-200.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges.* CIRIA Report 142. Construction Industry Research and Information Association, London.

National Rivers Authority (1994) *Discharge Consents and Compliance.* Water Quality Series N° 17. HMSO, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF GOLF COURSES

## 1. Introduction

This guidance note seeks to identify the potential impacts of golf courses upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for environmental studies carried out in connection with golf course proposals. The potential impacts of golf courses are of interest to the NRA because of the authority's responsibilities for flood defence, pollution control, fisheries, recreation and conservation management.

Although legislation does not formally require a formal Environmental Assessment (EA) to be carried out for proposed golf courses, EA is a useful process to gather and convey information to those individuals and organizations, including the NRA, who may have an interest in the environmental effects of the proposals. The NRA may require certain environmental information in order to respond to the planning application, and to applications to the NRA as a licensing body (Section 3).

The responsibility for EA lies with the developer, although the NRA will make available relevant related information that it holds. It is advantageous to consult with the NRA and initiate the EA in advance of the detailed designs to enable the proper consideration of alternatives and the identification of any environmental constraints which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

## 2. Development control

Golf courses are subject to planning controls within the Town and Country Planning framework.

## 3. NRA licences

Under the terms of the Water Resources Act 1991, the National Rivers Authority has a variety of licensing powers that may be relevant to golf courses.

i. **Land drainage consent** - required for any works on the bed and banks of a river or construction of any structure likely to impede the flow (e.g. surface water outfalls).

ii. **Abstraction licences** - for abstraction from ground or surface waters, e.g. for irrigation.

iii. **Impounding licences** - for impounding of watercourses

iv. **Discharge consent** - for discharges to inland surface waters, groundwaters and coastal waters.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted.

## 4. Major/potential impacts upon the aquatic environment

### 4.1 Construction impacts

**Preparation of the working area and construction of the golf course** - This may result in damage to the site flora from direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. There may be a loss of bank stability from bankside operations. Wildlife may be affected that are dependent on trees and other vegetation, e.g. birds and bats may utilize trees as nesting' or roosting sites. The loss of shade provided by bankside trees may result in significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction, vegetation losses and buildings (e.g. clubhouses) may result in increased river flows and therefore flood risk. In addition, water resources may be affected by reduced infiltration of rainfall to aquifers. Runoff and soil disturbance may lead to soil erosion with subsequent pollution from raised levels of suspended solids, decreasing water quality. Pollution by suspended material may have effects on sensitive aquatic life from direct abrasion or from increased attenuation of light in turbid water. In addition, sedimentation in rivers may affect substrate characteristics for aquatic flora and fauna, and reduce the quality of gravels for fish spawning, particularly that of trout and salmon. Reduced fish stocks will affect angling opportunities for such stocks. Angling and recreation may also be impaired by bankside construction activities and changes to access. General construction activity may also disturb aquatic wildlife disrupting feeding and/or reproduction.

Archaeological interests may be damaged by soil excavation

**Machinery and Vehicles** - The general operation of machinery and vehicles may contribute to problems of soil compaction and soil instability. Leaking or spilled fuel and oil from stores, vehicles or machinery may contaminate both groundwater and surface waters.

**Near river construction** - Golf courses may be built adjacent to watercourses and artificial lakes may be constructed by excavating and/or impounding existing watercourses. The impacts caused by works carried out close to and within the watercourse, will include: direct damage to river banks, aquatic and riparian flora and fauna and their habitats; and impacts associated with pollution from high concentrations of disturbed sediments (with subsequent sedimentation) and from oil or fuel spills. Construction materials such as cement may also lead to pollution. Machinery and construction materials in the watercourse may also represent a barrier to migrating fish.

In addition, to the above impacts the watercourse river may become wider and deeper, altering the stream hydrology and geomorphology. This could have impacts on the riverine communities, including the loss of sensitive species. Algal blooms may potentially develop due to the increased retention time of stream water in ornamental lakes (and from the use of fertilizers).

### 4.2 End state/Operational impacts

**Clubhouse** - Disposal/treatment of sewage may have impacts on groundwater or surface water quality, particularly in rural locations distant from foul sewers.

**Landscaping** - Landscaping may result in the changes to flood plain storage area and flood flow routes, resulting in altered stream hydrography, increased runoff, localized erosion and an altered risk of flooding. Altered drainage characteristics, particularly in the vicinity of well-drained greens, will lead to associated changes to runoff, stream hydrology and infiltration of rainfall to groundwaters. The altered site drainage may cause an alteration in the grassland types and potentially could cause a loss in conservation value of the site.

**Irrigation** - Abstraction of surface waters for irrigation will cause a decrease in flow velocity, this may alter the sediment transportation and deposition regimes, thereby altering the nature of aquatic habitats. Lower flows also reduce a river's ability to dilute and flush out any contaminants that enter and affect downstream water users. Reduced river flows may present a barrier to fish migration and movement which may then affect breeding success and quality of fisheries. The temperature of rivers in low flow may rise more rapidly and, combined with other physicochemical changes such as reduced dissolved oxygen concentrations, may affect aquatic ecological communities, potentially killing sensitive species or causing them to migrate out of the area. Peak abstraction periods may often generally coincide with periods of low river flow. Abstraction from groundwaters will diminish groundwater resources and the flow of spring-fed streams.

**Fertilizer and pesticide application** - Fertilizers and pesticides applied to golf course will be carried in site runoff (particularly if rainfall occurs soon after application) and drainage. Chemical contamination of both groundwater and surface water may occur. Biological communities could be seriously affected by pesticides with a loss of sensitive species (both plants and animals). Fertilizers entering watercourses may increase the risk of algal blooms.

**Addition of dye** - The addition of dye to lakes may cause direct pollution. Where lakes are on line the dye will be transported into the river system.

**Mowings** - Grass mowings and other clippings may produce a polluting liquor when left to stand. Mowing itself and other maintenance activity may disturb sensitive wildlife.

## 5. Mitigation measures

Careful course design will minimize environmental impacts. The principal impacts of golf courses are generally short-lived and confined to the construction phase provided that adequate care is taken during the planning, construction and operation of courses. Alternative siting and designs of golf courses should be considered. Golf courses should avoid sensitive areas, or measures to protect such areas should be guaranteed. Sensitive areas include:
- river floodplains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The siting of access roads, storage tanks and waste disposal facilities used during construction and in operations should also be considered.

**Access roads** - Roads should avoid riparian zones, and use appropriate construction materials. Culverts should be avoided, but where required these should be designed so as not to disrupt fish movement and be a flood hazard through their blockage. Drainage from car parks should have oil/fuel interception systems included.

**Storage of fuel and equipment** - On-site equipment and materials used in construction and operation should be carefully stored. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Chemical and fuel stores should be locked.

**Drip trays** - Drip trays should be placed under stationary machinery to collect oil and grease.

**Waste disposal** - Sewage and other waste water should be disposed of to foul sewer, where available. At locations remote from such sewerage, adequate treatment facilities should be installed.

**Water features** - Water features designed into the golf course should generally be off-line as algal growth, chemical treatments etc. in on-line features will have a direct effect on river water quality.

**Storage of surplus winter water** - Constructed lakes will limit the need for restrictions on abstraction licenses and result in a more reliable supply. By designing these to receive site drainage, these may also act as balancing lakes, thereby reducing the impacts of runoff and spillages. Recirculation or aeration devices may need to be installed in order to maintain water quality. Reclaimed waste water may be a further viable source of water for irrigation purposes.

**Buffer strips** - Areas of land around watercourses, unaffected directly by the development, may be used to intercept runoff and reduce the amounts of sediment and nutrients entering such watercourses. Strips of at least 10 m should be left adjacent to any watercourses to provide a natural undisturbed corridor in which herbicides and fertilizers etc. are not used. Larger buffer strips may be required if the natural land drainage situation requires it.

**Pesticides and fertilizers** - should be used in accordance with the relevant guidelines, such as MAFF (1985) and NRA (1995). These chemicals should only be applied to playing surface and used minimally. Drainage from areas with fertilizers applied should not enter water bodies within or adjacent to the course. Fertilizers, pesticides, dyes, fuel, oil and other potentially polluting materials should be properly stored, e.g. secure bunded areas.

**Mowings** - should be stored/composted away from watercourses.

**Soil protection and restoration** - Compaction of soils may be reduced by restricting traffic movement, especially during wet conditions, and the use of protective boarding and low ground pressure machinery. If necessary, soil should be carefully removed and stored with subsequent reinstatement. If necessary subsoil should be ripped prior to the spreading of topsoil. Mixing of unlike soil materials and importing soils should be avoided where possible.

**Field drains and ditches** - These should be identified and carefully reinstated where appropriate to prevent flooding and maintain the character of the landscape.

**Habitat protection and creation** - Where possible valuable existing habitat features should be incorporated into course design and protected from change. Mowing regimes may be used to avoid sensitive periods (e.g. flowering, breeding). Further habitats should be created to compensate for habitat losses and to improve the landscape and wildlife potential for the site. The former Nature Conservancy Council has issued relevant conservation guidance (NCC 1990).

**Disturbance to wildlife** - Appropriate phasing of construction work to avoid noise and disturbing activity at sensitive times will greatly reduce environmental impacts. Sensitive times for bird populations include breeding season and migratory concentrations.

**Disturbance to recreation** - Careful timing operations should minimize such disturbance.

**Access** - Where access restrictions result from the development, arrangements for alternative access should be made with the provision of gates, bridges or stiles.

**Archaeological sites** - Sites and other interest should be preserved {in situ} where feasible with the provision of facilities for visitors. Relocation should be considered, where damage is unavoidable.

## 6. Baseline surveys

Baseline field surveys should be carried out that are appropriate with respect to timing, timescale and methods used. Surveys should preferably include those conducted at the same time of the season as the proposed construction, in the year prior to the works.

Field surveys should be sufficient to:

- establish the pre-construction (baseline) state of the site;
- allow the determination of critical environmental factors upon which to give rapid on-site advice during construction;
- determine the best operational conditions for the aquatic environment during construction such as water level in wetlands, water flow in rivers and allowable sediment load or deoxygenation effects on river biota especially fish;
- optimize the reinstatement of channels or wetland areas by the appropriate choice or extent of use of a specific technique; and
- identify construction practices with a high environmental risk, economic liability or publicity factor.

The surveys required are site specific but is likely to include physical, chemical, and morphological data on water, soils and topographic features in addition to the species and numbers of the major organisms present. Important indicator species include flowering plants, dragonflies, amphibians, reptiles and native and migrant birds. Red Data Book species and those which are otherwise designated as rare (i.e. in legislation) must also be specifically searched for in surveys. Information on aquatic invertebrates, fisheries, recreational use and the river corridor as a whole will also need to be collected.

## 7. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

## 8. General guidance and references

In general, there should be limit to the number of golf course developments in an area or type of area to reduce cumulative effects.

European Golf Association Ecology Unit (1995) *An environmental strategy for golf in Europe.* Pisces Publications. (Available from the Nature Conservation Bureau, 36 Kingfsher Court, Hambridge Road, Newbury, Berkshire, RG14 5SJ.)

Ministry of Agriculture, Fisheries and Food (1985) *Guidelines for the use of herbicides on weeds in or near to watercourses and lakes.* MAFF. (NB these guidelines are currently being updated).

NRA (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

Nature Conservancy Council (1990) On course conservation: *Managing golf's natural heritage.* NCC, Peterborough.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF POWER STATIONS

## 1. Introduction

This guidance note seeks to identify the potential impacts upon the water environment of power station developments. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of proposed power stations. The NRA has an interest in power stations due to its general environmental responsibilities and particularly with respect to the control of pollution of surface waters. Legislation requires that an EA should be carried out for most proposed power station developments with the production of an Environmental Statement (ES). The responsibility for this assessment lies with the developer. It is advantageous to conduct the EA in advance of the design phase to enable proper consideration of alternatives. Similarly, early contact with the NRA will enable identification of sensitive areas and other environmental constraints affecting proposals. The EA's conclusions require proper justification and raw data should be accessible to interested parties, such as the NRA.

Wind farms and hydropower schemes are subject to other guidance notes.

## 2. Development control

Under the Electricity Act 1989 the construction or extension of power stations with a capacity of 50 megawatts or more requires consent from the Secretary of State for Trade and Industry. Smaller power stations fall under planning legislation, i.e. the Town and Country Planning framework.

In addition to planning regulations, power stations may be subject to the requirements of the Environmental Protection Act 1990, e.g. the application of BATNEEC (Best Available Techniques Not Entailing Excessive Costs) for emission controls and the Duty of Care in the management of wastes.

## 3. Environmental Assessment

Under the Electricity and Pipe-line Works (Assessment of Environmental Effects) Regulations 1989 (SI 1989 N° 167) an ES must be submitted to the Secretary of State for Trade and Industry in connection with applications which are made for:

i. the construction or extension of a nuclear power station;

ii. the construction or extension of a non-nuclear generating station with a heat output of 300 megawatts or more;

iii. the construction or extension of a non-nuclear generating station with a heat output of 300 megawatts or more where the Secretary of State is of the view that the development would be likely to have significant effects upon the environment; and

iv. the placement on land of an overhead line or the construction or diversion of a pipeline of 10 miles or more in length, where the Secretary of State takes the view that the project concerned would be likely to have significant environmental effects.

As such, EA may be required not only for power stations but also for the transmission of associated fuel supply (e.g. gas and oil) via pipelines and the transmission of generated power via overhead lines.

Local Planning Authorities may require EA for smaller schemes not subject to consent from the Department of Trade and Industry.

For those cases where an EA may not be formally required the EA process and ES may be a useful process to convey environmental information to interested or licensing bodies such as the NRA.

## 4. NRA licences

Power station developments may require a number of licences from the NRA, such as:

- **discharge consent** - for discharges to controlled waters (i.e. inland surface waters, coastal waters up to three miles offshore and groundwaters);
- **abstraction licence** - for abstraction from groundwater or surface waters;
- **impounding licence** - for impounding surface waters; and
- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

In addition, consent must be obtained for the introduction of fish into an inland water, e.g. for stocking fish into cooling water lagoons or into rivers as a mitigation measure.

In addition, Her Majesty's Inspectorate of Pollution (HMIP) is the competent authority for consenting discharges within integrated pollution control (IPC) arising from the EPA 1990.

## 5. Major potential impacts upon the aquatic environment

### 5.1 Construction impacts

Impacts are described primarily for fossil fuel and nuclear power stations. The principles of fossil fuel plants may be easily applied to smaller plants, such as municipal waste incinerators and biomass plants burning 'renewable' fuels such as straw and coppiced wood. Further detail on the general impacts of construction, may be found in other guidance.

**Land take** - Land take will result in the loss of wildlife habitats, species and possibly migration pathways.

**Preparation of the working area and construction of roads and buildings** - General construction activities may result in damage to the site fauna and flora from direct damage and physical disruption of soils. The temporary disposal of excavated materials may extend the affected area. Bankside operations are likely to cause bank instability. Fauna and flora may be affected by habitat loss from within water channels, from banksides and from other habitats such as wetlands. For example, bankside trees and vegetation may be used by birds and bats as nesting and roosting sites and by otters. Bankside trees may also provide shade to aquatic systems; tree loss may thus result in raised water temperatures and increased growth of plants and algae.

Increased runoff resulting from soil compaction and vegetation losses may result in reduced infiltration to groundwater and an altered hydrological response to rainfall, with increased short-term river flow. Infiltration loss may result in a lowered water table, affecting associated habitats (e.g. wetlands), water resources. River baseflows may also be reduced affecting aquatic life, water recreation and resources. Increased river flow in response to rainfall may result in erosion of river substrate, banks and associated aquatic life, changes to river geomorphology and the risk of flooding.

During a major construction of this type large quantities of fuel/oil and machinery may need to be stored on site. These may present a high risk to the aquatic environment from leakage and spillage.

**Construction of inlet and discharge pipes** - As much of the construction will inevitably have to take place within or near water channels, works may lead to the mobilisation of soils and sediments, and increased suspended solid loads. Erosion and runoff may add to these loads. Such deterioration in water quality may affect organisms which are sensitive to abrasion, siltation and to increased attenuation of light from water turbidity. Siltation may significantly alter substrate characteristics resulting in an increasing dominance of silt tolerant organisms and reduced egg-fry survival of fish using gravels for spawning, e.g. trout and salmon. Altered fish stocks will have implications for angling opportunities.

Access to watercourses or water bodies, for navigation, angling, other water-based activities may be disrupted. Maintenance of flood defences may also be prevented.

**Associated development** - Contractors parking, storage and accommodation areas may significantly extend the area of impacts, albeit temporarily. Transmission lines and the infrastructure for fuel supply and storage may similarly extend the area of impacts. The planting of crops for biomass production may result in a change of land use and associated impacts.

## 5.2 Operational impacts

**Abstraction of water for cooling** - The severity of impacts from abstraction will depend very much on the location and volumes abstracted, particularly in relation to river or tidal flows. Abstraction may cause reductions in river flows and changes to tidal regimes, dispersive characteristics and sediment transport; thereby significantly altering the nature of aquatic habitats. Reduced river and tidal flows also reduce the system's ability to flush, mix and dilute any contaminants. If too great a volume of water is abstracted the lack of water may present a significant barrier to fish migration and movement. The reduced volume and mixing of water in a system may also cause physicochemical changes such as increased temperature, and reduced dissolved oxygen, affecting sensitive aquatic communities. Secondary impacts may be exerted on other water users, e.g. fishermen.

At the point of abstraction, impingement of fish may occur at intake screens. Fish larvae and other smaller organism may also become entrained. Losses may be seasonal, particularly in relation to migration patterns and breeding cycles, such as the downstream migration of salmon smolts in rivers and the release of barnacle larvae in marine situations.

Further guidance notes on the impacts of abstraction are available.

**Cooling Water Discharges** - Cooling water discharges may have a thermal impact on the receiving water. Increased water temperature may alter growth, metabolism, food and feeding habits, reproduction, movements, migration and behaviour in aquatic organisms. Raised temperature may also alter the ability of organisms to deal with other stresses, such as diseases and other forms of pollution. These effects may be compounded by changes in water physicochemistry such as concentrations of dissolved gases. For example, the oxygen carrying capacity of water decreases with increasing temperature.

Cooling water may also contain significant concentrations of chemicals, some added, some concentrated by evaporative processes (particularly in recirculation systems). Chemicals in the cooling water may include salts, acids, biocides and antifoulants. These each may have impacts on the quality of receiving waters.

**Other discharges** - Effluents from processes such as flue gas desulphurization (FGD), may contain high concentrations of various contaminants, e.g. boron, fluoride, chloride and metals. These may have significant impacts on aquatic life and water resources.

Radioactivity releases from nuclear power stations into the aquatic environment is strictly controlled and are unlikely to cause acute toxicity problems under normal circumstances. However, long-term low level releases may result in chronic effects (e.g. reductions in fecundity, growth, and longevity) through bioaccumulation. Major spills or leaks of intermediate and high level wastes would have serious implications for aquatic life if surface waters were affected. Groundwater contamination would result in a long term loss of water resources.

Leakage from recirculating (cooling) systems may cause a significant drop in the water quality of receiving waters due to the concentrated nature of contaminants.

Further guidance notes on the impacts of abstraction are available.

**Site runoff** - The volume of site runoff will be increased by the increased paved area due to roads, car parks, buildings etc. As mentioned above, this may result in an altered stream hydrology and a lowered water table, affecting aquatic life, flood risk and water resources. Site runoff may also be acidic and contain various contaminants, including suspended solids, arising from particulates and leachate from dust, fly ash and coal stocks. Site runoff may also contain radioactive contamination. As a result, the receiving water may suffer a deterioration in quality, and in the loss of sensitive species. Bioaccumulation of contaminants may also occur in the food chain. Changes in the substrate characteristics and river bed morphology may also occur due to sedimentation.

Spills of fuel, chemical and wastes may cause pollution if these enter groundwater or surface waters.

**Pulverised fly ash (PFA)** - Disposal of PFA may extend the area of impact through and water quality effects. Aquatic habitats may be damaged or lost by dumping in aquatic or riparian sites, e.g. coastal lagoons. Leachate from PFA may contaminate groundwater and surface waters. Further contamination and suspended solids may arise from runoff and windblow. Damage to aquatic life may be via mechanisms of toxicity, smothering and habitat change or loss.

**Other wastes** - Other wastes from power stations may include boiler cleaning wastes, sludges from water treatment plant, ash from oil-fired boilers and gypsum from FGD. Further wastes may arise from the decommission of power stations. Impacts may arise from these other wastes.

**Atmospheric emissions** - Atmospheric emissions from combustion processes may lead to local deposition of contaminants derived from fuel sources and more remotely lead to the deposition of so-called "acid rain". Localized deposition of contaminants from municipal waste incinerators may be particularly significant (see separate guidance on waste management).

Acidification of freshwater systems may arise from acid rain in soft water areas, where the buffering capacity is low, causing damaging effects on the water quality of receiving waters and their communities. Low pH in itself can be acutely toxic to fish but effects are more usual through associated changes in aluminium toxicity. Acid-stressed streams may show reduced densities and diversity of aquatic fauna, including fish.

Atmospheric emissions from power stations may also contribute to alteration of the global climate.

**Landscape** - Power stations (and cooling towers in particular) will generally have a significant impact on landscape. The impact may be exacerbated by aerial emissions, including steam, and heaps of fuel and PFA.

**Noise** - Generators and site activity may disturb wildlife and nearby recreational users.

**Associated developments** - Transmission lines may be a significant cause of mortality of migratory birds through collisions. Extraction of fuel (or growth of biomass) will have impacts at source. Quarrying of limestone for FGD may have significant impacts at the point of extraction. Decommission of power stations may have a variety of impacts, depending on the power station type and mode of operation.

## 6. Mitigation Measures

**Siting and design options** - power stations and associated developments should avoid sensitive locations such as:

- river floodplains;

- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- vulnerable aquifers; and
- acid sensitive areas.

Where space is limiting, gas or oil-powered generators may be preferable to coal-fired stations as these require less space, not requiring large areas for coal stockpiles and for PFA storage or disposal. More strategically, the power station should fit in with national energy policies and the consideration of alternatives such as energy conservation measures. Power station location should take into account the contribution to acid rain in sensitive areas.

Routing of transmission lines should also be considered at an early stage. In particular, locating lines underground may be a more environmentally acceptable (but costly) alternative in sensitive locations.

**Preparation of the working area and construction of roads and buildings** - The area of working should be minimized as far as possible. Measures should be taken to avoid valuable habitats and to reinstate semi-natural areas damaged by construction. To avoid damage to soils in construction, soils may be protected *in situ* or temporarily removed. To protect soils, compaction may be averted by restricting traffic movement, especially in wet conditions, and the use of protective boarding and low ground pressure machinery. If necessary, when removed soil is to be is reinstated, the subsoil should be ripped prior to the spreading of topsoil. Mixing of unlike soil materials should be avoided. Excavated soil should be carefully disposed of, away from more sensitive locations and possibly off-site. Stored and other exposed soil or spoil should be covered to minimize silt runoff.

**Habitat creation** - Opportunities of suitable habitat creation should be maximized, incorporating those types unavoidably lost. Such habitats should be installed at an early stage and translocation of sedentary species considered.

**Drainage** - Temporary drainage during construction and more permanent drainage on completion should incorporate facilities such as storage tanks, oil separators (interceptors), silt traps, wet balancing ponds, and reed bed treatment (as appropriate) to reduce water quality impacts of runoff and spillages. Field drains and ditches should be identified and carefully reinstated to prevent flooding and maintain the character of the landscape. Flood compensation measures should be incorporated where the flood plain is affected. These should be designed in consultation with the NRA.

**Construction of inlet and discharge pipes** - Inlet and discharge pipes should not be positioned where these may affect other intakes. Positions for discharge pipes should be chosen which have good mixing potential. Care should be taken using cement and other potentially toxic construction materials near water.

**Abstraction** - Damage to aquatic ecosystems may be reduced by primarily using water abstracted from lagoons rather than directly from rivers or estuaries. Abstraction will still also be required to replace losses from evaporation. However, abstraction needs to top-up lagoons will be reduced and may be done at times of high flow (or tide), where possible. At some sites direct abstraction for cooling may the only practicable option. Recirculation should be used where possible.

Loss of fish due to impingement can be reduced by employing 'warning stimuli' for example air bubbles, light, electricity, water velocity and pressure changes. Physical barriers such as fine screens or clinker bunds surrounding the area from which water is extracted may also be used to protect aquatic fauna. Carefully organized operating schedules may also reduce the risk of impingement and entrainment as may reducing the intake velocity. Solomon (1992) provides guidance on intake design and techniques that may be used to reduce impacts. It may be feasible to compensate for the loss of fish by the operation of a hatchery and stocking programme as agreed with the NRA.

**Cooling water discharges** - To minimize contamination of receiving waters cooling water should be passed through balancing lagoons or treated before it is returned. In freshwater systems it may be possible to dechlorinate effluents using sulphur dioxide injection.

Discharges should be made through dispersal mechanisms and/or at times of high flow to maximize dispersion and dilution of contaminants.

The need for antifoulants to prevent the growth of aquatic organisms in the cooling water circuit may be reduced by designing systems with smooth surfaces and by maintaining a high water velocity ($>2.5\ ms^{-1}$) to create conditions unfavourable for attachment. Reversal of cooling water once every four weeks may achieve some degree of control, but requires some extra heating and is costly.

**Atmospheric emissions** - The quality of air emissions may be improved by fuel gasification, flue gas desulphurization, the use of low sulphur fuels, controlled combustion and NOx and other emission controls. Greater dispersion of emissions may be achieved from higher emission stacks.

**Disposal of pulverised fly ash (PFA)** - The incorporation of a settling system into the plant process will limit the amount of fly ash discharged into receiving waters. Damping down or covering of PFA may also reduce inputs from windblow. PFA disposal sites may be restored by covering of topsoil etc. and subsequently may be suitable for other land use.

**Nuclear waste** - Nuclear waste should be minimized and contained using stringent measures. Low level releases should consider cumulative effects from other discharges and background radiation.

**Storage of fuel and equipment** - On-site equipment and materials should be carefully stored both in construction and operations. Proper bunding should be provided for fuel tanks, away from water and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Drip trays should be placed under stationary machinery to collect oil and grease.

**Noise impacts** - Suitable screening will reduce noise impacts, as will having construction and operating procedures that avoid sensitive times or locations.

**Visual impacts** - Visual impacts may be reduced by screening with suitable native plants and bushes.

## 7. Baseline surveys

Pre-construction surveys should be appropriate with respect to timing, timescale and methods used and preferably include surveys at the same time of the season as the proposed construction, in the year prior to the works. Relevant surveys may be ascertained by consultation with interested parties, such as the NRA, but may include:

- hydrology;
- river/coastal geomorphology;
- water quality;
- water resources;
- river corridor surveys;
- aquatic biology;
- fisheries; and
- archaeology.

Predictive modelling of various factors such as dispersion of temperature plumes and other discharges and emissions will usually be required.

## 8. Monitoring and audit

Monitoring should be carried out that is relevant to the predicted impacts and mitigation measures. It should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit of data should also include an assessment of compliance with agreed management practices.

## 9. Further guidance and references

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to procedures*. HMSO, London.

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide*. HMSO, London.

Hawkes, F.B. (1974) Heated discharges from thermal power stations. *Effluent Water Treatment Journal*, 14 No.10, 549-559.

Langford, T.E. (1983) *Electricity Generation and the Ecology of Natural Waters*. Liverpool University Press.

National Rivers Authority (1994) *Discharge Consents and Compliance - the NRA's approach to control of discharges to water.* Water Quality Series No. 17. HMSO, London.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls.* R&D Report 1. National Rivers Authority, Bristol.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF WIND FARMS

### 1. Introduction

This guidance note seeks to identify the potential impacts of wind farms upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of wind farm schemes. The potential impacts of wind farms are of interest to the NRA because of the authority's responsibilities for pollution control, fisheries, recreation and conservation management. Early consultation with the NRA will help to identify any environmental constraints and sensitive areas which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Consideration should not only be given to the impacts of generators alone, but also to associated development such as access and haul roads, buildings, substations, transformers and the installation of cables and overhead lines.

### 2. Development control and Environmental Assessment

Wind farm developments come under the Town and Country Planning framework. As such an EA may be required as wind farms are now listed under Schedule 2 of the 1988 Town and Country Planning (Assessment of Environmental Effects) Regulations as 'wind generators', following amendment to those regulations (which previously did not consider wind farms) by the introduction of the Town and Country Planning (Assessment of Environmental Effects) (Amendment) Regulations 1994. As Schedule 2 projects a formal EA may be required where the scheme is anticipated to have significant environmental effects. The following indicative criteria and thresholds are given by DoE Circular 7/94 (Welsh Office 20/94) to assist whether EA is required:

- the development is located within or is likely to have significant environmental effects on a National Park, the Broads or the New Forest, and Areas of Outstanding Natural Beauty, Sites of Special Scientific Interest or heritage coast; or
- the development consists of more than ten wind generators; or
- the total installed capacity of the development exceeds 5 megawatts.

Wind farms are given particular attention in Planning Policy Guidance on *Renewable energy* (PPG 22) issued by the Department of the Environment/Welsh Office 1993. This states that where an EA is not requested *per se*, applicants will be expected to have full regard to the environmental implications of proposals.

The installation of overhead power lines associated with wind farms may qualify for a separate EA under the Electricity and Pipe-line Works (Assessment of Environmental Effects) Regulations 1990 (SI 1990 No.442).

### 3. NRA licences

Authorization will be required from the NRA for any works on the bed or banks of a river or construction of any structure likely to impede the flow (as a land drainage consent). Other authorizations that may be required include discharge consent, abstraction and impounding licences. Authorizations must be obtained in advance of any construction, regardless of whether planning permission has been granted. In order to consider applications for authorization, the NRA will require certain environmental information which would normally be included in an ES, if produced.

## 4. Major/potential impacts

Impacts upon the aquatic environment are expected particularly during the construction phase, and may not only arise from the erection of wind generators, but also from the construction (and use) of access and haul roads, substations, transformers and the installation of underground cables and overhead lines.

### 4.1 Construction impacts

**Water hydrology** - Runoff will increase due to the larger paved area and from soil compacted during construction and road use. Increased runoff will generally result in greater flow and flood risk downstream. Where roads and trenches need to cross a floodplain or river, impediment of groundwater or surface water flow may occur.

**Water quality** - High suspended solids, from the road and excavation works, may result in an increased bed load, possibly causing deoxygenation, and downstream sedimentation. The latter may be particularly unacceptable where salmon spawning areas are affected, as siltation reduces egg survival. Pollution from cement, concrete and leakage and/or spillage of fuels and oil from construction machinery and storage tanks may cause further deterioration of water quality. Contamination may also occur from litter, vehicle emissions, oil and grease, tyre wear, and the breakdown of road surfaces. Deterioration of water quality may adversely affect aquatic life and compromise downstream water supplies. Furthermore, reduced water quality may affect a watercourse's aesthetic quality and its recreational value. Groundwaters may be polluted by oil, fuel and other contaminants.

**Channel morphology** - Channel morphology may be altered by the downstream deposition of sediments, increased sediment and bed load.

**Habitat disturbance** - Disturbance of both aquatic and terrestrial habitats may occur from direct land take, deterioration of water quality, altered channel morphology, construction noise and vibration, and from the storage and disposal of excavated soil. Severance of migratory paths may occur from the site construction works or from the installation of associated cables or overhead lines which may have to cross a variety of habitats including river corridors, wetlands and other potentially sensitive areas. Damage may result in the loss of sensitive species.

**Access** - Access to the development and associated area may be impeded by construction activity.

**Heritage, archaeology and landscape** - Heritage/archaeological interest may be affected through the destruction of known and unknown features. Visual disturbance may occur during construction there are likely to be a significant number of lorry movements and the use of cranes for the erection of turbines may be particularly obtrusive.

### 4.2 End-state impacts

**Water hydrology** - Stream hydrology can be affected by increased runoff from the increased road surface area and compacted soils, which may remain to be a problem during the operational phase.

**Water quality** - The use on site of fuel, lubricants and chemicals, such as pesticides, may affect water quality. In general, contaminants from runoff should pose a lesser risk than during the construction phase due to the reduced volume of traffic and cessation of excavation activity.

**Ecological disturbance** - Disturbance may arise due to noise and vibration from the wind generators; sensitive species may be particularly affected. Also, bird fatalities may arise from direct collision with generator blades.

**Landscape** - The landscape may be particularly affected by wind farms.

## 5. Mitigation measures

**Location/design** - Alternative siting and design should be considered and the environmental acceptability of the options considered. In addition to the wind farm itself, the siting of access roads, substations, transformers, storage tanks and waste disposal facilities used during construction and thereafter should be considered along with the routing of underground cables and overhead lines. Wind farms and associated developments should avoid riparian zones and wetlands.

**Storage of fuel and equipment** - On-site equipment and materials should be carefully stored. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity.

**Drip trays** - Drip trays should be placed under stationary machinery to collect oil and grease.

**Buffer areas** - Areas of land around watercourses, unaffected directly by the development, may be used to intercept runoff and reduce the amounts of sediment and nutrients entering such watercourses.

**Riparian management** - Measures should be considered to protect or enhance the aquatic environment and the value of distinctive riparian habitats. It must be remembered that increased ecological diversity is not necessarily an improvement as a rare species may only exist where competition is low.

**Road construction** - Access/haul roads should avoid riparian zones, minimize erosion, use appropriate construction materials, have culverts designed so as not to disrupt fish movement, design roadside drains to drain road areas only and to discharge to buffer areas where drainage water is likely to contain high sediment loads.

**Archaeological and other interest** - Such interests should be preserved {in situ}, where feasible, with the provision of facilities for visitors. Relocation should be considered, where damage is unavoidable.

**Access** - Restrictions should be mitigated for by the construction of gates, bridges or stiles, or arrangements for alternative access to be made.

**Compaction** - Compaction and other soil damage may be reduced by restricting traffic movement and the use of protective boarding and low ground pressure machinery. If necessary, soil should be is reinstated, and subsoil should be ripped prior to the spreading of topsoil. Working on wet soils and mixing unlike soil materials should be avoided. Excavated soil should be carefully disposed of, possibly off-site.

**Drainage** - Field drainage should be reinstated. Header drains and water stops should be installed in cable trenches. Oil separators (interceptors), silt traps, wet balancing ponds, open ditches, soakaways and reed bed treatment should be used where appropriate to reduce water quality impacts.

**Loss of habitats** - The working width of roads, cable laying operations etc. should be restricted. Traffic should be restricted to suitable roads, which may often be temporary. Special provisions may be required where habitats need to be protected. For example, if a wetland needs to be crossed, bog mats could be employed. Damaged habitats should be restored to their former soil profiles with reseeding (using seeds from the original, disturbed vegetation or vegetative fragments). Grazing animals should be excluded during restoration.

**Disturbance to wildlife** - Operations should be carefully timed, e.g. to avoid breeding seasons, and sited to cause minimum disturbance.

**Use of pesticides and fertilizers** - Relevant guidance on the use of pesticides should be followed (e.g. MAFF (1985), FC (1989) and NRA (1995)). The NRA should be notified where appropriate and watercourses should be avoided.

**Noise** - should be minimized by careful selection of machinery and the use of baffles or screens, where appropriate. Timing of operations and rate of discharge should be restricted. The siting of operations should be chosen carefully.

## 6. Baseline surveys

The developer should ensure that the characteristics of the area of the development are ascertained and sensitive areas identified, such as:

- bird feeding and roosting areas and any migratory paths;
- rivers supporting valuable fisheries, e.g. salmon, and salmonid spawning areas;
- areas supporting rare species;
- saltmarshes and other wetlands;
- rivers and river corridors of high ecological or amenity value;
- contaminated land likely to lead to polluting runoff; and

- "vulnerable" aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

The characterization should be conducted by a review of information currently held by competent authorities and surveys conducted or commissioned by the developers. The surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case specific but may include surveys of water quality, hydrology, river corridors, fisheries, recreational use, buildings, physiographic and geological features, sites and objects of archaeological or historic interest and the general landscape.

## 7. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is strongly recommended and should not only make use of baseline surveys but also consider further prescheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

## 8. References and general guidance

British Wind Energy Assoication (1995) *Best Practice Guidelines for Wind Energy Development.*

English Nature have published nature conservation guidance for renewable energy projects (EN 1994) which concentrates on wind power. The Department of Trade and Industry have produced guidance (DTI 1992) on the EA of cross-country pipelines, which may be applicable to the laying of power cables.

Department of Trade and Industry (1992) *Guidelines for the Environmental Assessment of Cross-Country Pipelines.* HMSO, London.

English Nature (1994) *Nature Conservation Guidelines for Renewable Energy Projects.* English Nature, Peterborough.

Forestry Commission (1989) Provisional Code of practice for the use of pesticides in forestry. Occasional Paper 21. Forestry Commission, Edinburgh.

Ministry of Agriculture, Fisheries and Food (1985) Guidelines for the use of herbicides on weeds in or near watercourses and lakes. (NB these guidelines are currently being updated).

NRA (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF HYDROELECTRIC POWER PROJECTS

## 1. Introduction

This guidance note seeks to identify the potential impacts of hydropower upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of hydropower schemes. This note complements the NRA pamphlet *Hydropower Developments and the National Rivers Authority*. The NRA has an interest in hydropower developments primarily due to the potential impacts on water resources, fisheries, stream ecology and flood defence. Although formal EA may not be required for smaller schemes, the NRA will require certain environmental information as part of land drainage consent, and impounding and abstraction licensing procedures. The responsibility for such an assessment of environmental effects lies with the developer. Larger hydropower generating schemes such as major tidal schemes, hydroelectric dams and pumped storage reservoirs have not often been proposed in recent years, the main emphasis being on smaller non-tidal run-of-river schemes utilizing subsidies available under the Non-Fossil Fuel Obligation schemes. This guidance note reflects that emphasis. The impacts of larger schemes are similar to those of smaller schemes, although they are likely to be more significant and are combined with the added impacts of reservoir or barrage development.

## 2. Development control

A hydropower development falls under Schedule 2 of The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199) as "an installation for hydroelectric energy production". As such, formal EA is only required for projects which are likely to have significant effects by virtue of factors such as their size, nature or location.

The following licences/consents may be required from the NRA:

- **impounding licence** for schemes involving the construction or alteration of impounding works such as dams and weirs;
- **abstraction licence** for schemes in which water is abstracted physically by leat or pipe; and
- **land drainage consent** for schemes which may affect land drainage and possibly flood risk.

## 3. Major/Potential impacts

### 3.1 Construction impacts

The main impacts of construction will arise from the installation of a weir or dam to provide the required head of water, the laying of pipelines and cables, and the construction of turbine houses. These impacts may be particularly significant where schemes are proposed in remote scenic areas.

#### 3.1.1 Weir/dam construction

There will be direct disruption of rivers by in-channel works. Physical activity will disturb bankside and benthic sediments leading to raised levels of suspended solids, and potentially other contaminants. Dewatering of bunded areas may have similar effects. Other water quality effects may arise from the significant risk of oil, fuel and cement spills or leakage. On site activity and haul roads may impact upon riparian and aquatic flora and fauna either directly (e.g. through physical damage, noise) or indirectly (e.g. through soil compaction). Alterations to river flow during construction may affect aquatic life, particularly migratory fish. Settling of disturbed sediments may alter the quality of substrates, reducing their value to migratory fish and many invertebrate species.

### 3.1.2 Pipelines and cables

Pipelines, tunnels and leats may be installed to convey water with a sufficient head to turbines. Cables may be laid to convey generated electricity into the national grid. In general, the longer the length of river impacted, the longer the pipeline and the longer the electric cables, and the greater the potential environmental impact. Disturbance may directly affect riparian flora, but may also have indirect effects due to alterations in site drainage brought about by any channelling effect of underground pipeline/cable trenches. Such drainage may also lead to raised suspended solids in watercourses as may dewatering activities. Disturbance of contaminated soils may also result in pollution of watercourses. Mechanical activities may result in fuel or oil pollution. Other effects may be visual disturbance and damage to archaeological interests. Overground pipelines and overhead cables may be particularly intrusive in upland scenic areas. Where tunnels are required there may be impacts of noise during tunnelling and associated with the disposal of spoil.

### 3.1.3 Turbine houses

The construction of turbine houses and other buildings may have effects of habitat loss through land take, visual impacts during and after construction, associated sewerage and cement and oil pollution.

## 3.2 End state/Operational impacts

The main end state/operational impacts will arise from hydrological changes arising from the retention of water behind a dam, diversion of river flow through pipelines and from the discharge regime for power generation. Buildings, maintenance and generation activities may also have some effects. Although the generation of power is not a consumptive use, there may be water resource implications to upstream users.

### 3.2.1 Impoundment

For smaller hydropower schemes in rivers there are unlikely to be major changes in water quality brought about by prolonged retention time of water allowing siltation, the development of algal blooms and thermal stratification. However, raised water levels and reduced velocities may affect aquatic life. Riparian vegetation may be inundated or affected by a raised water table. Raised groundwater levels may also have implications for drainage patterns and buildings.

The impounding structure may present an obstacle to migrating fish, other wildlife and the passage of canoes and other craft.

### 3.2.2 Discharge Regime

The discharge regime may have major impacts on downstream water quality, flora and fauna. The extent of impacts will be dependent on the nature of the scheme, i.e. whether water is diverted away from the river and whether it is stored before discharge, the nature (hydrograph) of discharges if these occur and the extent of residual flow. For many schemes there will not be a discharge regime as such, with turbines utilizing ambient flow only. Where water is stored, there will be periods of reduced flow followed by the high flows released during generation which may cause washout of banks, sediments and organisms. In addition, there may be the risk of flooding associated with the retention and discharge of water. Changes in flow may disturb downstream users (e.g. anglers, canoeists), have a visual impact, affect the behaviour of migratory fish and have safety implications.

The passage of water through turbines may oxygenate water, generally benefiting aquatic life, although supersaturated water may be damaging. Fish and other aquatic life may also be damaged by passage through turbines.

### 3.2.3 Abstraction of water

Where water is by-passed through turbines, there will be a reach dependent on the extent of residual flows and periodic low flows. The impacts of low flows will be a reduction in wetted width and water depth, a reduced dilution or flushing capacity and increased sedimentation, all potentially affecting aquatic life.

### 3.2.4 Other operational issues

The maintenance of turbines may involve the use of antifoulants, chemicals and lubricants, which would have an adverse effect on water quality if they were to enter the watercourse.

### 3.2.5 Water resources

The abstraction of water and discharge regime may affect holders of existing water rights, particularly downstream of impoundments and along the lengths of river where flow is diverted through pipelines to the turbines. In addition, the NRA will need to have regard for the use of water for hydropower and this may limit future upstream abstraction.

## 4. Mitigation measures

Alternative sites should be adequately considered where the expected environmental impacts are significant. Mitigation measures should include the following:

- taking care in construction to control site drainage and to minimize the disturbance of sediments and the risk of oil, fuel and cement pollution;
- covering exposed soil/spoil;
- effective on-site sewerage;

- using sympathetic building materials and/or underground construction;
- minimizing disturbance caused by haul roads and pipeline construction;
- landscaping of blasting stone (from tunnelling) or use of stone in road or dam construction;
- avoidance of sensitive plants or areas;
- avoidance of sensitive periods, e.g. fish spawning and bird breeding times;
- burying of pipelines and cables with appropriate enhancement and reinstatement of overlying soils and vegetation;
- restriction of abstracted quantities, depending upon river flows;
- provision for residual flow to safeguard the river environment and other users, including provision for measurement and control of the flow;
- provision of adequate monitoring and control;
- provision of fish pass to allow fish migration (upstream and downstream);
- provision of screens at intake and discharge points to stop fish entering turbines; and
- having a water head and discharge regime as a compromise between ideal generation and environmental and other needs.

## 5. Baseline surveys

River corridor, macroinvertebrate, fish and bird surveys using approved techniques will be required along any river reach affected by impoundment, flow diversion or discharge. In addition, surveys will be required of areas affected by routes of haul roads, pipelines and cables. Landscape and archaeology interest should also be assessed. A detailed study of river hydrology should be made to assess not only generating capacity, but also the minimal acceptable flow and impact of the scheme on wetted area.

The NRA have produced a guidance leaflet on environmental information that may be required.

## 6. Monitoring and audit

Monitoring should be carried out using appropriate methods to assess impacts predicted and the success of remedial/mitigation works. Operational practice, such as abstraction rates and residual flows should also be recorded.

## 7. General guidance and references

There is likely to be a limit on the number of hydropower developments permitted within a particular catchment. Further details may be found in the relevant catchment management plan. The following may also be useful.

Department of the Environment/Welsh Office *Planning Policy Guidance Note on Renewable Energy*. PPG 22. HMSO. (A supplementary annex addresses hydropower in more detail).

National Rivers Authority *Hydropower Developments and the National Rivers Authority.*

National Rivers Authority *Hydropower Developments. Guidance on Environmental Information Required*

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF OIL REFINERIES AND OIL EXPLORATION

## 1. Introduction

This guidance note seeks to identify the potential impacts oil refineries and oil exploration upon the water environment. It is intended to act as a fairly detailed scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the Environmental Assessment (EA) of such development. The NRA has an interest in oil refineries and oil exploration, particularly due to potential impacts on water quality, water resources, flood defence, fisheries and conservation.

EA may be required under planning legislation. However, even where EA is not formally required, it is a useful process by which to convey environmental information required by the NRA and others commenting on development proposals and related applications. The responsibility for obtaining information and/or EA lies with the developer. There are distinct advantages to contact the NRA and conduct environmental studies well in advance of proposed development, such that environmental constraints can be identified and avoided, where possible, and such that appropriate mitigation measures can be incorporated into the planned development. The developer should be able to demonstrate a reasonable consideration of alternatives for a scheme. There should also be the consideration of the wider implications of the development, such as impacts arising from associated infrastructure such as pipelines.

This note does not consider offshore oil exploration and extraction in detail as these are generally outside of the NRA's jurisdiction. However, some coverage is given as developments are occasionally sited in areas within the NRA's remit, i.e. within estuaries, embayments and the 3-mile limit.

## 2. Development control

Developments, other than those offshore, will generally fall under the Town and Country Planning Framework. These may include exploratory drilling operations. Under the recently consolidated General Development Order the NRA are statutory consultees for development for the purposes of refining or storing mineral oils and their derivatives. Offshore developments are subject to controls exercised by the Department of Trade and Industry (DTI).

## 3. Environmental Assessment

Under the terms of the Town and Country Planning (Assessment of Environmental Effects) Regulation 1988 (SI N° 1199) an EA is mandatory for project types listed in Schedule 1 of the regulations, and would normally be required for those listed under Schedule 2 when significant impacts are expected. Relevant Schedule 1 projects include:

"a crude-oil refinery (excluding an undertaking manufacturing only lubricants from crude oil) or an installation for the gasifaction and liquefaction of 500 tonnes or more coal of coal or bituminous shale per day".

Relevant Schedule 2 projects include:

"extracting petroleum";
"a surface industrial installation for the extraction of coal, petroleum, .....";
"the surface storage of fossil fuels";
"the storage of petroleum or petrochemical or chemical products"; and
"the modification of a development which is carried out, where that development is within a description mentioned in Schedule 1".

Guidance on the significance of impacts for Schedule 2 projects has been produced by the Department of the Environment and Welsh Office (as DoE Circular 15/88 (WO Circular 23/88) and DoE/WO (1989)).

## 4. NRA authorizations

The following licences/consents may be required from the NRA in connection with the development.

i. **Discharge consent** - for discharges to groundwaters, inland surface waters and coastal waters up to three miles offshore.

ii. **Abstraction/impounding licence** - for abstraction or impounding of water.

iii. **Land drainage consent** - will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

## 5. Major potential impacts

Primarily the NRA will be concerned about impacts relating to water quality, water resources and flood defence. In addition, there will be concern over impacts on fisheries, aquatic biology, conservation, recreation and amenity, archaeology, and stream hydrology and geomorphology. In general, it will be necessary to demonstrate that none of the water quality objectives applied to watercourses are adversely affected. Pollution of surface and groundwaters may result in criminal proceedings, as may any breaches of licence or consent conditions.

### 5.1 Construction phase

Many of the issues relating to the impacts of construction of oil refineries (and to a lesser extent exploration sites) are covered in more detail in separate guidance on the impacts of general construction.

**Land take** - Virtually all new developments involve some degree of land take. This results in the general destruction of habitats and displacement or loss of species. Often refineries are sited in coastal locations that may include sensitive habitats, e.g. saltmarshes, wetlands.

**Preparation of the working area and construction activity** - Site flora and fauna may be damaged through direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. Excavations may damage archaeological interests. Bankside tree removal may affect certain associated flora and fauna, e.g. birds and bats may use trees as nesting or roosting sites. Bankside trees may also provide shade for rivers; tree loss may result significantly increased river temperatures and plant or algal growth.

Increased runoff resulting from soil compaction and vegetation losses may result in increased river flows and therefore flood risk. In addition, groundwater may be affected by reduced infiltration of precipitation to groundwater. Runoff and soil disturbance may lead to increased soil erosion with an associated increased sediment load in rivers. High suspended solid loadings reduce water quality with direct impacts on both aquatic life and the aesthetic appearance of a watercourse. Sedimentation of solids will in turn alter substrate quality for invertebrates and plants. Fish spawning areas may be particularly damaged by siltation, reducing egg survival. Dust generated on site may add to loads of suspended solids.

The general operation of machinery and vehicles may contribute to problems of soil compaction and stability. Leaking or spilled fuel and oil from vehicles, machinery or storage may contaminate both groundwater and surface waters.

The use of inadequate sewerage and waste disposal facilities may result in pollution of groundwater or surface waters.

The construction of buildings or other facilities in or near water channels may present a flood risk. Culverting or diversion of river channels will have impacts to both land drainage characteristics and aquatic life.

Noise and vibration may disturb wildlife and recreational users of waters.

**Construction of a nearshore facility** - Nearshore facilities may cause direct damage to aquatic habitats. Indirect impacts may stem from water pollution such as high concentrations of disturbed suspended sediments (with subsequent sedimentation) and from seepage, leaks and spills of oil, fuel, and construction materials (e.g. cement). Facilities, machinery and construction activity may represent a barrier to navigation and migrating fish. Tidal currents may be altered with knock-on effects on bottom substrates and associated life. Blasting may be necessary to penetrate hard rocks, this will cause direct destruction and disturbance of marine habitats, fauna and flora and will result in direct alteration of the bed morphology.

Pipelines may need to constructed and may have a variety of impacts, not least from leakage (see separate guidance on pipelines).

## 5.2 Operational impacts

**Drilling** - On land, drilling may lead to a variety of impacts, particularly due to direct or near contact with aquifers resulting in groundwater pollution. Pollution of groundwaters may occur by contamination from additives, drilling muds, lubricants, oil itself and the connection of isolated aquifers.

Drilling nearshore may also place coastal waters at risk. Noise and vibration from drilling operations may cause habitat disturbance resulting in the loss of sensitive species from the area. Drilling muds may contaminate sediments in the vicinity of drilling platforms and potentially over more extensive areas.

**Refineries** - Discharges from refineries may potentially have major impacts through the effects of heat, oil and other components of effluents. The effects may include the direct loss of species, gradual changes in the ecological communities, and contamination of fish stocks. Discharges to rivers may result in significantly increased river flows and velocities which may cause bank degradation and erosion.

Runoff from the refinery and associated area is likely to become contaminated with oil and fuel from operations and vehicles resulting in a deterioration of receiving water quality.

Major abstractions for cooling water or refinery processes may affect water resources, and river and tidal flows (with associated impacts on aquatic life). Direct impingement or entrainment of aquatic life may occur at the point of abstraction.

The siting of refineries in sensitive coastal areas may have implications for particular species or species groups, such as wading birds, and also for the coastal landscape. Noise and vibration from drilling and refinery operations may cause habitat disturbance resulting in the loss of sensitive species from the area.

**Oil pollution** - There is a strong risk of groundwater and surface water pollution through the loss of oil. Losses may range from comparatively small, frequent emissions resulting in chronic problems, e.g. seepage during drilling, or from the regular evacuation of ballast water from oil tankers, to major spillages resulting in acute pollution, e.g. from the sinking of a tanker or rupture of storage facilities or pipelines. The effects of oil pollution will depend not only on the quantity of oil lost but also on its quality, i.e. on the fractions involved. The lighter aromatic compounds tend to be volatile and may rapidly dissipate, but also tend to be very toxic to most living organisms, with the degree of toxicity increasing with degree of unsaturation; the heavier aliphatic fractions tend to be less toxic but sink (being heavier than water) and bind to sediments. Thus, the less toxic aliphatic fractions may remain in the sediment for a long time; degradation is slow and therefore can result in long term, low level chronic effects.

Oil can exert toxic effects at all levels of the food chain causing lethal and sublethal effects. The drastic smothering effects of oil on aquatic birds is well known, feathers may become saturated with oil affording the bird less buoyancy, waterproofing and heat insulation; death often follows. Animals may also be exposed to oil pollution through drinking contaminated water. In lower concentrations, oil can still have serious consequences, e.g. very low levels of oil can reduce the viability of fish eggs. Fish flesh may become tainted and therefore this may affect the value of a fishery.

Even small traces of oil in water may be noticeable as a surface film and may thus have an aesthetic impact. Oil on beaches can be a particular aesthetic nuisance.

Emulsifiers and dispersants which may be used to help clear an oil spill may themselves be very toxic and exacerbate the effects of the spill. Similarly, extinguishants used in the event of fire may have toxic effects.

**Produced water** - Produced water can exceed 50% of well output in a mature well. This contains various polluting and often toxic substances and may be a major source of pollution during the life of a well.

**Increased shipping** - Shipping activity will increase when a new oil refinery or extraction point is commissioned due to the import and export of oil. This increased activity may hinder existing shipping and will increase the risk of a major accident involving tankers. Pollution risk will also be increased due to ballast water, sewage and waste disposal. Ballast water may also introduce species that are not indigenous to the receiving water, causing ecological and other impacts through competition and the transmission of disease and parasites.

**Subsea structures** - Subsea structures and offshore wells may represent navigational hazards. However, they may also represent artificial reef structures benefiting fish and other marine life.

## 6. Mitigation measures

The location and size of developments will be key factors in determining impact significance. Where possible, construction activities (including laying of access roads, pipelines etc.) should avoid sensitive areas, such as:

- flood risk areas, e.g. floodplains;
- wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers or coastal areas supporting valuable fisheries or nursery areas;
- areas of conservation importance;
- vulnerable aquifers; and
- upland areas of catchments with particular sensitivities.

The timing of construction and operation should consider disturbance to wildlife and other users. Impacts may be reduced by avoiding sensitive periods, e.g. bird nesting and fish spawning seasons, where possible.

**Construction practice** - Developers and their contractors should follow building regulations, codes of good practice etc., where these are applicable. Staff, including supervisors, should be made aware of risks of site activity to the environment. Dealing with the environmental impact of the site should be the responsibility of a designated manager, who should establish contact with local NRA staff at the earliest possible opportunity. Ideally, an environmentally qualified and experienced site supervisor will be employed to ensure the protection and enhancement of the environment.

Permanent and temporary land take should be minimized and original habitat features maintained where possible.

The storage and handling of soil should be such that the area affected is minimized whilst the structure of soils to be restored is maintained as much as possible (i.e. avoid mixing topsoil with underlying material). Stored and other exposed soil or spoil should be covered to minimize silt runoff. Imported material should be avoided where this may contain polluting substances or propagules of invasive plants. Seeding of landscaped areas may or may not be appropriate with suitable seed. Borrow pits should not be excavated in sites of wildlife or other value. Opportunities to create wetland or other habitats should be considered.

Compaction of soils by heavy machinery should be minimized, particularly in sensitive sites, with the use of boards and other temporary supporting structures. Compaction may also be reduced by minimizing activities in during wet weather conditions.

**Habitats** - Wetlands, trees and other important habitats should be retained, where possible. Where breeding/roosting/hibernating sites are inevitably going to be affected, access to these should be prevented prior to and during the relevant periods. Opportunities should be sought to create new habitats, particularly to simulate those lost due to the development.

**Chemical storage** - Suitably storage should be used for chemicals, fuel and oil in areas away from watercourses and drains with adequate bunding should spillage occur. Drip trays should be used with pumps and other such machinery to catch leaking oil. Particular care should be taken when pouring concrete or handling cement near watercourses. The risk of pollution from vandalism and theft should be reduced by using tamper proof valves, adequate fencing and security. If pollution of any sort does occur, the NRA should be notified immediately and prompt action taken to minimize effects.

Adequate sewerage and waste disposal facilities and arrangements should be made such that there is a minimal risk of pollution.

**Site runoff** - The runoff from the site, including car parks and access roads should be routed through facilities to reduce the impacts of runoff itself. Oil separators (interceptors) may be generally appropriate and isolation points and/or underground storage tanks should be designed into the drainage system in loading, process and storage areas with a high risk of spillage. The discharge of cleaner runoff may be regulated by passage through balancing ponds/retention basins. These may also act as sediment traps, as a buffer against poor water quality from storm runoff, and provide useful aquatic and wetland habitats.

**Noise** - Noise and intrusion should be minimized and avoided at sensitive times, e.g. in the evenings where birds roost in adjacent sites.

**Dust** - Dust may be dampened down to reduce aerial transmission, but should not be washed into drains etc. Vehicle (wheel) wash facilities should be adequately constructed with containment of the effluent for proper treatment and disposal.

**In-channel work** - In-channel works should avoid periods of maximum disruption to relevant seasonal activities, i.e. navigation, fish spawning. Interruption to recreational access and navigation should be minimized, although public safety should not compromised. Methods of working should be used that minimize the extent of disturbance to the banks and bed of the river.

**Culverting** - Culverting should be avoided where possible. When it is unavoidable, the bottom should be continuous with that of the natural stream to allow the uninterrupted passage of fish, and headroom should be maximized to permit light entry and the passage of birds and mammals. Adequate headroom and/or screening will also reduce flood risks.

**Waste disposal** - Ballast water, sewage and other wastes - should be disposed of to reception facilities on land, where possible. Where disposal at sea is permitted, this should not occur inshore due to the risk of pollution and/or contamination of inshore waters.

**Contingency plans** - Contingency plans to be used in the event of a major pollution event should be established, including emergency procedures on how to deal with the pollution itself. Where appropriate, booms should available. They should be stored so that they are readily accessible and maintained in good condition. Their condition should be inspected regularly. Staff should be trained regularly on deployment methods so that in the event of an emergency they can be deployed properly, quickly and efficiently. Dispersants should only be used when necessary and where possible, use should be restricted to those which are known to have the lowest toxicity. Emergency procedures should consider the impacts of fire fighting from extinguishants and runoff.

**Subsea structures** - The decommissioning of an offshore rig should consider the relative merits of retention/removal of subsea structures (although removal may initially be stipulated by the DTI).

## 7. Baseline surveys

In order to ascertain the detailed impacts of a development, baseline surveys will generally be required, although some relevant information may be available from the NRA and other bodies. Surveys should be conducted at relevant times of year using recommended methods. The findings should highlight particularly sensitive sites, habitats or species.

In general, the NRA will require information (from surveys or otherwise) on:

- river corridor survey (for wildlife conservation);
- fisheries;
- aquatic biology;
- water quality;
- water resources;
- hydrology and hydrogeology;
- landscape/amenity;
- recreation;
- river/coastal geomorphology; and
- archaeology.

## 8. Monitoring and audit

A monitoring programme relevant to assessing predicted impacts and the success of mitigation works would be welcomed.

Audits of site management practices during construction may ensure that the construction techniques and practices proposed in the environmental assessment do not alter without due consideration for the environment.

## 9. General guidance and references

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989) *Environmental Assessment: A guide to the procedures*. HMSO, London.

Department of Trade and Industry (1992) *Guidelines for the Environmental Assessment of Cross-country Pipelines*. HMSO, London.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land Contamination & Reclamation*, 1 No. 4, 197-200.

Menzie, C.A. (1982) The environmental implications of offshore oil and gas activities. *Environmental Science and Technology*, 16 No. 8, 454-472.

NRA (1992) *Policy and practice for the protection of groundwater.* HMSO, London.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FORESTRY PROJECTS (to encompass clearfelling, replanting, mid-rotation work)

### 1. Introduction

This guidance note seeks to identify the potential impacts of forestry projects (to encompass clearfelling, replanting, mid-rotation work) upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA) for both statutory and non-statutory Environmental Assessments (EAs). The NRA has an interest in forestry projects due to impacts on water resources, water quality, fisheries, recreation, conservation and flood defence. EA may be required for such projects depending on their scale, nature and expected impacts. The impacts of afforestation should at no time affect the river quality classification, statutory water quality objectives and other use- related environmental quality standards.

The NRA is not necessarily contacted formally about afforestation projects as it not a statutory consultees for these. In addition, the NRA are not specifically mentioned in the Forestry Commission leaflet guide *Consultation for Grant and Felling Applications* (FC 1993a). However, the location, scale, nature and timing of planting schemes are of prime interest to the NRA and the Forestry Commission booklet *Forests and Water Guidelines* (FC 1993b) encourages consultation with water regulatory authorities for all forestry operations and, in particular, for harvesting and pesticide, fertilizer and sewage sludge applications. Consultation with the NRA at an early planning stage will help identify environmental constraints and sensitive areas to be avoided, thus obviating the need for redesigning the scheme or mitigating avoidable impacts at a later stage.

### 2. Development control

Environmental Assessment of afforestation projects may be required under the Environmental Assessment (Afforestation) Regulations 1988[1] (SI 1988 N° 1207). The need for EA is ascertained by the Forestry Authority on receipt of a grant application for a new planting proposal, EA not being required for replanting schemes (FC 1993c) or for felling itself. An EA is likely to be deemed necessary where the scheme is expected to have significant effects on the environment and may lead to harmful ecological change in terms of the physical, biological or cultural environment. Relatively little afforestation occurs outside of the Woodland Grant Scheme (1% in 1988).

It should be stressed that it would be desirable for EA to be carried out on a wider scale than is required under statutory procedures, thus including smaller planting schemes in less sensitive areas and also clearfelling and replanting operations.

### 3. NRA licences

Forestry projects may require NRA licences or consents, most notably land drainage consents

[1] Reported to be revised soon in Department of the Environment Circular 3/95 (Welsh Office 12/95).

will be required for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Examples of such works include access roads, river crossings and diversions. A consent requires the consideration of the consequences to all other NRA functions to be made.

## 4. Major/Potential impacts

In addition to the location and scale of the project, and the tree species to be planted, the potential impacts of forestry projects vary depending on the stage of the development of the forest and associated activities. Generally, at each stage there will be a risk of oil, fuel or chemical spillage from inadequate storage facilities, leading to surface or groundwater pollution. Vehicle and machinery movements and other activities may disturb sensitive wildlife and lead to soil compaction and erosion. The design of the riparian zone and activities within it are critical to the establishment and protection of good quality terrestrial and riverine habitats.

### Ground preparation

Ploughing and other ground preparation may destroy ground flora and fauna and possibly damage archaeological interests. The use of ploughing to install site drainage may cause major impacts on stream hydrology, generally with a more rapid hydrograph response to rainfall with an increased flood risk downstream. The lowering of the water table as a result of drainage will also have hydrological and ecological implications. Rapid drainage from forestry sites may lead to severe erosion of drainage channels, high suspended solid loads and siltation of receiving streams. This will have significant negative effects on the quality of spawning gravels of salmonid fish. High suspended solids may also have more direct effects on water quality, aquatic life and visual amenity. In addition, disturbance and drainage of soils may lead to raised colour, manganese and iron levels in receiving waters with implications for stream ecology and water treatment. General vehicle movements may add to concentrations of suspended solids in runoff; oil or fuel leaks may cause further contamination of surface or groundwaters. The aesthetic appearance of recently ploughed sites may have a visual impact. Planting itself should not have major impacts.

### Road construction

The development of access routes may lead to siltation of streams due to changed runoff patterns and high loads of suspended solids from the new road surface and from the construction of bridges and culverts. Cement and raw concrete entering watercourses may be toxic to aquatic life. Culverts may restrict the upstream migration of fish. Road construction may eventually lead to improved recreational access to the site, but initially access would be disrupted by site activity.

### Tree Maturation

There will be an increasing acidification potential arising from the action of the developing forestry canopy, filtering out atmospheric pollution (dry and wet deposition). Soft surface waters may be acidified causing the loss of plants, fish, invertebrates and associated species (e.g. dipper), principally due to the mechanism of acidity and aluminium toxicity. The developing canopy will also cause increased shading of riparian and stream plant communities. The thermal characteristics of streams will be influenced by the degree of shade, with more constant, less extreme temperatures featuring in wooded streams. As the trees mature there may be a decreasing water yield from the site and catchment through interception and evapotranspiration losses, with possible low flow impacts and a reduced water resource downstream. Low flow impacts include reduced habitat for fish and other aquatic life, increased temperature and algal growth and a decreased dilution capacity.

### Harvesting

General harvesting and associated vehicle movements may lead to raised suspended solids in site drainage and runoff, with associated water quality and siltation problems. Further road building (with associated impacts) may be required to facilitate access for timber haulage. The use of vehicles, chain saws and other machinery may lead to oil pollution. With the felling of trees, streamflow and water yield may change, depending on land use pre- and post-planting, and modifications to site drainage. Trash dams, consisting of woodland debris may obstruct fish movements and change river habitat features. Access will generally be disrupted during harvesting, but may be generally improved with the construction of haulage roads. Aesthetically, the appearance of the site will deteriorate post harvest. Ecologically, the site will initially be colonized by pioneer species rather than by the pre-afforestation flora. Tree debris remaining on site and soil leaching will continue to contribute nutrients to receiving waters. In base-poor catchments nitrate loss may enhance surface water acidity and aluminium concentrations for the first few years after clearfelling.

### Pesticide, fertilizer and sewage sludge application

Pesticides applied in the establishment phase may contaminate surface and groundwaters. Eutrophication may arise from the seepage of fertilizer (e.g. phosphate) into surface waters. The use of organic fertilizers such as sewage sludge may also result in organic and other forms of pollution (i.e. raised BOD, lowered dissolved oxygen, raised heavy metals). Fertilization of the soil will also affect plant communities in both terrestrial and aquatic habitats.

### Replanting

Replanting or restocking will lead to impacts similar to initial site preparation from ploughing and drainage activity, and from the application of fertilizers and pesticides. Acidification may be further enhanced. The opportunity to redesign according to current best practice should allow some impacts to be ameliorated.

## 5. Mitigation measures

Primary considerations should be the location and size of proposed forestry projects. Where possible, the proposed siting of forestry projects should avoid sensitive areas such as: groundwater source protection zones; potable supply catchments; catchments with limited water resources; acid sensitive catchments; flood risk areas, and areas of other importance (e.g. for conservation, fisheries, or recreation). Cumulative impacts may be reduced by a scaling down the extent of forestry proposals.

Foresters should follow the *Forests & Water Guidelines* (FC 1993b) for good practice with respect to NRA concerns. In these guidelines, the concept of critical load of atmospherically-derived acidity is explained in the context of strategic considerations of the catchment capacity for new planting. The guidelines also include detailed recommendations with respect to ground preparation, the use of buffer strips or areas, management of riparian vegetation, road construction, harvesting, the storage of fuel and chemicals and the use of pesticides and fertilizers. Liaison with the NRA is the rule to ensure appropriate implementation of these guidelines. Some key recommendations are outlined below.

**Ground preparation** - Minimize cultivation, do not plough deeper than necessary, align drains near parallel to contours, end drains away from watercourses and install silt traps, maintain silt traps and drains outside of sensitive periods (October to May for salmonid fish).

**Use of buffer areas** - Design uncultivated areas of land around watercourses to reduce the amounts of sediment and nutrient runoff.

**Riparian management** - Manage such that the aquatic environment is protected or enhanced and the value of distinctive riparian habitats is maintained or enhanced, follow *Forest Nature Conservation Guidelines* (FC 1990).

**Road construction** - Avoid riparian zones, minimize erosion, use appropriate construction materials, design culverts so as not to obstruct fish movements, design roadside drains to drain road areas only and to discharge to buffer areas where drains are likely to carry high sediment loads.

**Harvesting** - Liaise with NRA and consider phased felling in sensitive catchments, stack timber away from watercourses, plan to minimize stream and drain crossings in felling and extraction.

**Storage of fuel and chemicals** - Use bunded tanks or stores away from watercourses (preferably off-site) and lock when unattended. Avoid fuel spillages.

**Use of pesticides and fertilizers** - follow guidance such as *the Provisional code of practice for the use of pesticides in forestry* (FC 1989) and those on the use of herbicides on weeds in or near watercourses and lakes (MAFF 1985, NRA 1995a). Consult the NRA before the use of any pesticide in or near water or aerial applications on land adjacent to water.

## 6. Baseline surveys

Assessments should be made of various aspects of environmental quality from studies of existing data (NRA, conservation bodies etc.) and from desk and field surveys using approved techniques. The NRA should identify which data they hold that are relevant and highlight particularly sensitive sites.
Key factors to be considered are:

- site geology, soils and vulnerability to acidification;
- water quality of surface and groundwaters;
- water resources, flood defence and hydrology; fisheries;

- other fauna and flora, river corridor surveys;
- landscape;
- recreation and other uses.

## 7. Monitoring and audit

Monitoring that is relevant to predicted impacts and mitigation measures is desirable and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices. Further guidance on monitoring and best practice are being developed as part of the NRA Forestry Business Plan (NRA 1995b).

## 8. General guidance and references

A variety of literature and guidance is available as listed below. *The Forests and Water Guidelines* (FC 1993b) should be used as a key reference.

Forestry Commission (1989) *Provisional Code of Practice for the Use of Pesticides in Forestry*. Occasional Paper 21. Forestry Commission, Edinburgh.

Forestry Commission (1990) *Forest Nature Conservation Guidelines*. Forestry Commission.

Forestry Commission (1993a) *Consultation for Grant and Felling Applications*. Forestry Commission, Edinburgh.

Forestry Commission (1993b) *Forests and Water Guidelines*. Third edition. HMSO.

Forestry Commission (1993c) *Environmental Assessment of New Woodlands*. Forestry Commission, Edinburgh.

HM Government (1994) Sustainable Forestry: The UK Programme. CM 2429 HMSO.

Ministry of Agriculture Fisheries and Food (1985) *Guidelines for the use of herbicides on weeds in or near watercourses and lakes*. (NB these guidelines are currently being updated)

NRA (1995a) *The use of herbicides in or near water*. NRA (Anglian Region), Peterborough.

NRA (1995b) *NRA Forestry Business Plan*. National Rivers Authority, Cardiff.

Wolstenholme, R., Dutch, J., Moffat, A.J., Bayes, C.D. and Taylor, C.M.A. (1992) *A Manual of Good Practice for the Use of Sewage Sludge in Forestry*. Forestry Commission Bulletin.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF THE REDEVELOPMENT OF CONTAMINATED LAND

## 1. Introduction

This guidance note seeks to identify the potential impacts of the redevelopment of contaminated land upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for environmental impact studies at redevelopment sites. The NRA has an interest in the redevelopment of contaminated land due to its general environmental duties and in particular due to its responsibilities for water quality and water resources. There is often a significant risk of pollution of groundwater and surface waters from such developments, amongst other impacts.

Contaminated land is defined in the Environment Bill as "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that significant harm or pollution of controlled waters is being, or is likely to be, caused". Examples of contaminated land include: former waste disposal facilities, such as completed landfill sites, waste tips, sewage sludge dumping areas etc.; former industrial sites, such as gas works, manufacturing and engineering works etc.; the sites of former mines; and land previously used for agriculture or horticulture. Contaminated land may be derelict or in operational use; the contamination is often contained, until redevelopment. (The Department of the Environment (DoE) has recently issued draft guidance for local authorities in determining whether land is contaminated for the purposes of the Environmental Protection Act 1990, the existing legislation relevant to such land).

In order for the NRA to comment on planning applications and/or issue relevant licences or consents (Section 4), the Authority will require certain environmental information. As such environmental studies may be required, even if there is not a legal requirement for formal Environmental Assessment (EA) with the production of an environmental statement (ES). The responsibility for environmental studies/assessment lies with developer. There are distinct advantages to contact the NRA at an early stage of proposals and conduct studies/EA in advance of detailed planning so that a proper consideration of alternatives (siting, construction techniques, design etc.) and mitigation measures can be considered.

Relevant information on the policy of the NRA on contaminated land are set out in the NRA document *Contaminated Land and the Water Environment* (NRA 1994a) and in *National guidelines on redevelopment of contaminated land* (NRA 1994b). In addition, a further policy document *Policy and Protection of Groundwater* (NRA 1992) may be relevant with respect to constraints on the redevelopment of contaminated land arising from the risk of pollution of groundwaters. Relevant Government guidance includes DoE Circular 21/87 (now somewhat dated), the more recent Planning Policy Guidance, PPG 23 *Planning and Pollution Control*, and that from the Interdepartmental Committee on the Redevelopment of Contaminated Land (e.g. ICRCL 1987). The DoE and Welsh Office have recently published *Framework for Contaminated Land: Outcome of the Government's Policy Review and Conclusions from the Consultation Paper - Paying for our Past* (DoE/WO 1994). Whilst the Government encourages the development of contaminated land, thereby minimizing avoidable pressures for new development on greenfield sites, remedial action may be required where there are unacceptable actual or potential risks to the environment. The DoE Contaminated Land Report series (DoE 1994a, 1994b, 1994c, 1994d, 1994e) may be relevant to developers.

New government guidance will be forthcoming in 1995; the NRA guidance is provided for interim use until this has been published.

## 2. Development control

Development controls applicable to redevelopment of contaminated land will vary according to the nature of the proposal. Typically, projects may fall under the Town and Country Planning framework.

## 3. Environmental Assessment

The redevelopment of contaminated land *per se* does not require EA. The relevant regulations, e.g. the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199), refer to specific project types such as industrial estates and power stations which may require an EA and be constructed on contaminated sites. Also, the need for an EA is often assessed on the basis of significance of expected impacts. Potentially, significant impacts from the disturbance of contaminated land may thus trigger the need for EA.

Regardless of any statutory requirement for a full EA, the NRA will require a site investigation as a condition or prerequisite of any planning permission at contaminated sites posing a threat to water resources. Such an investigation will include hydrogeological assessment and a risk-based impact assessment of the effect of the development on groundwater and surface waters. In general, the "source-pathway-receptor" philosophy should be employed as set out in DoE (1994a).

## 4. NRA licences

The NRA are responsible for issuing the following licences/consents that may be required in the redevelopment of contaminated land.

i. **Discharge consent** - for discharges to groundwater or surface waters (e.g. from dewatering operations). Prohibition Notices may be used to control discharges from clean up (pump and treat) operations.
ii. **Abstraction licence** - for abstractions from surface or groundwaters, including testing boreholes.
iii. **Impounding licence** - for the impoundment of surface water.
iv. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission to discharge must be obtained prior to any discharges.

## 5. Major Potential Impacts

In general, the key impact of concern to the NRA in the redevelopment of contaminated land will be pollution of groundwater or surface waters, which may occur to a major degree. Contamination of waters will be regarded as pollution when either of the following factors occur (NRA 1994a):

- there is a breach of a water quality standard (WQS) or other internationally agreed standard/action, e.g. North Sea Conference 1987 (Reduction of Red List substances); or

- there is evidence of poor water quality or harm to the systems the water supports.

Typical substances in contaminated land include heavy metals, acids/alkalis, ammonia, phenols and other organic compounds, especially halogenated solvents (Beckett *et al.* 1992). Microbial contamination may also be at significant levels. Leaching of these substances may affect water quality affecting uses of the water (e.g. for abstraction) and aquatic life. Factors potentially causing pollution and other impacts are indicated below.

### 5.1 Site investigation

Although an essential element of successful redevelopment work, investigation boreholes may disturb both natural and man-made impermeable layers below contaminated sites leading to the release of contaminants and hence groundwater pollution. Such layers may include concrete foundations and basement floors, and clay layers.

### 5.2 Site preparation

Site demolition and stripping can cause the release of contaminants by damaging impermeable layers both above and below contaminated sites and exposing contaminated layers to rainfall resulting in the generation of noxious leachate. Exposure of contaminated soils may add to leachate problems through oxidative processes. Excavations may lead to the further release of contaminants from damage to pockets of concentrated contamination (e.g. in underground tanks, drums and pipes) and may damage underground services, sewers, culverts and drains with direct contamination of these. Also, excavation activity may lead to high levels of suspended solids and other contamination of runoff, causing pollution of receiving waters. Settlement of solids may affect the substrate as a habitat from both siltation and contamination of sediments. The dust and windblow may be further sources of solids entering watercourses.

Dewatering of construction areas within or adjacent to contaminated land may draw contaminated water out of containment. Disposal of pumped water may cause pollution of receiving waters. General flooding of sites during redevelopment may lead to the dispersal of contamination and pollution.

During the preparation and development of sites, access to or through the site may be restricted, potentially affecting public recreation and maintenance of flood defences etc.

## 5.3 Foundations

Piling may puncture impermeable layers containing contamination, thus providing a route for leachate to enter groundwater (or surface waters). Some piling techniques (e.g. vibro replacement piling) are likely to enhance the downward migration of contaminants.

## 5.4 Development

The development itself may give rise to particular impacts related to the development itself rather than due to the prior contamination of the site. These development specific impacts may be covered by other NRA guidance. However, some of the impacts of development relate more specifically to the fact that the site is contaminated.

Where development results in a rise in groundwater levels, e.g. from the creation of water bodies or the cessation of abstraction, the rise in water table may lead to mobilisation of contaminants and subsequent pollution.

Measures to minimize infiltration and the laying of impermeable surfaces (roads, car parks and buildings) may result in increased runoff potentially causing flow-related problems impacts (e.g. flooding, erosion) in receiving waters.

## 6. Mitigation measures

Mitigation measures are described briefly below - for detailed guidance see NRA (1994b). The NRA may object fundamentally to a development unless there are adequate environmental safeguards.

## 6.1 Site decontamination

Mitigation options will be very much case specific, depending on factors including the nature of contamination and the intended use of the land once redeveloped. The government advocates a "suitable for use" approach to remediating contaminated land, a view supported by the NRA.

Permanent clean-up of contaminated sites using physical, chemical or biological techniques are available. In addition, chemical treatment may not restore a soil to an uncontaminated state, but merely 'lock-up' contaminants that may be released at a later date. The use of microbial degradation may present a risk, albeit short term, to groundwater quality unless adequate precautions are taken, such as lining the site. Removal of the contaminated ground for disposal elsewhere may be a viable option and is certainly the most common practice today, but merely transfers the problem to the receiving site. (Such disposal is subject to the same waste disposal regulations as apply to other 'controlled wastes'). Often the pragmatic approach, where the nature of the development is not seriously compromised by the contamination, is to redevelop the land with contamination *in situ*, incorporating various measures to contain or encapsulate the contaminants. Examples of such possible measures are considered below.

## 6.2 Containment

### 6.2.1 Site investigation

Investigative boreholes should be drilled using methods which minimize the risk of spreading contamination deeper into the ground. Temporary drilling casings should closely follow the base of the hole as it is drilled, and all perched water tables should be sealed out as effectively as possible. Wherever possible clay layers below the site should be left intact. Special precautions may be necessary when it is necessary to penetrate an underlying aquifer (see Naylor *et al.* (1978) for guidance). Temporary boreholes should be sealed up using appropriate methods, e.g. bentonite/cement grouts or plugs.

### 6.2.2 Site preparation and development

Methods of stripping and preparing the site should be chosen that minimize the risk of disturbing containment of the contaminated land.

Where surface soils may carry contamination, wheel washing facilities should be installed and utilized for vehicles leaving the site.

Alternative choices of piling techniques may be used to reduce the likelihood of damage to impermeable layers and the release of contaminants.

Dewatering operations should only be done with prior consultation with the NRA. Waters with a high pollution potential may need to be discharged to sewer with the appropriate consent of the relevant water utility. Tankering off site may also be an option.

Covering over of contaminated land with impermeable surface such as hot-rolled asphalt will reduce the risk of infiltration of rainfall and leachate generation. The risk of leachate production will increase with permeability of cover material. However, the overground flow of runoff should not be blocked by demolished, excavated or other material.

The construction and use of balancing lagoons may reduce the impacts of runoff or leachate from a site which may be inevitable at various stages of redevelopment, particularly following heavy rainfall.

Containment of horizontal underground flow may be achieved by the insertion of cut-off walls and/or by the installation of leachate collection systems. Upward movement of contaminants may be prevented by the installation of capillary breaks.

## 6.3 Restoration of access

Rights of way and other prior uses of sites should be restored as part of site redevelopment.

## 7. Baseline survey

Surveys should be designed in consultation with the NRA. The following may generally apply.

**Site investigation** - Following a review to ascertain historical uses of the site (and hence probable contaminants), an extensive site investigation should be carried out, incorporating carefully drilled investigation boreholes and trial pits to study groundwater levels, groundwater quality and the nature of contamination. Site investigations may be reduced in scale or targeted where the results of any previous investigations are available.

**Water quality analysis** - Analyses should be conducted relevant to the contamination anticipated from the previous use of the site. For example, analysis for ammonia, polynuclear aromatic hydrocarbons (PAHs) phenols, tars and other organics would be appropriate for the site of former gas works.

**Leaching tests** - Tests should be conducted using NRA recommended methodologies (NRA 1994c) to assess the potential of the contaminated land for groundwater pollution from leaching. (Note that although the ICRCL provides guideline figures for contaminated land, known as trigger values, these relate primarily to the impact on people or plants of direct contact with the contaminated material, and do not indicate the danger to water resources. Leaching tests provide a better indicator of such risks.)

**Hydrogeological and hydrological studies** - Studies should be carried out on a wide scale to ascertain the drainage flow patterns. The water quality, uses and ecological status of receiving (or potentially receiving) waters should also be ascertained; the NRA may hold relevant data. The studies should be designed to enable an impact assessment to be undertaken to predict effects on underlying groundwater, nearby surface water systems and any target receptors such as abstraction boreholes in the area (DoE 1994a).

**On-site ecology** should be studied; often contaminated sites may develop a unique flora. River corridor surveys may be appropriate.

## 8. Monitoring and audit

Monitoring programmes should be established that are relevant to predicted impacts and remedial/mitigation works. Generally, permanent groundwater quality monitoring boreholes may be required to detect changes to, and the movement of, contamination.

## 9. Further guidance and references

Bardsley, P.J. (1994) Redevelopment of contaminated land - a view from the NRA. In proceedings of conference *The Legal, Technical and Practical Issues of Building on Contaminated Land*, London.

Beckett, M., Dobbs, A.J. and Gourlay, D. (1992) The impact of contaminated land on freshwater quality. In: *Freshwater Quality, Additional Reports undertaken for the Royal Commission on Environmental Pollution*. HMSO, London.

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DoE (1994b) *Guidance on preliminary site inspection of contaminated land.* Contaminated Land Research Report 2.

DoE (1994c) *Documentary research on industrial sites.* Contaminated Land Research Report 3.

DoE (1994d) *Sampling strategies for contaminated land* Contaminated Land Research Report 4.

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF WASTE MANAGEMENT

## 1. Introduction

This guidance note seeks to identify the potential impacts upon the water environment of developments for the purposes of waste disposal. It is intended to act as a fairly detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the assessment of the environmental effects of such developments. The NRA has an interest in waste disposal sites due to its general environmental responsibilities and particularly with respect to the control of pollution of groundwater and surface waters. Legislation may require a formal Environmental Assessment (EA) of the proposed development. Otherwise, an EA may still represent a useful process to gather and convey any environmental information required by those commenting on such development proposals.

The responsibility for the assessment lies with developer. Conclusions made in the assessment will require proper justification and the raw data upon which conclusions are based should be accessible, if required. There are distinct advantages to both contact the NRA and to conduct an EA at an early stage such that any environmental constraints (e.g. the proximity of vulnerable aquifers) can be identified in advance of detailed planning and so that there can be the proper consideration of alternatives and mitigation measures.

Under the Environmental Protection Act 1990 (EPA 1990), types of waste are divided into two major categories:

- **controlled waste** - household, industrial and commercial waste or any such waste; and
- **special waste** - controlled waste of any kind that is dangerous or difficult to treat, keep or dispose of.

Certain other wastes, namely radioactive waste, some wastes from mines and quarries, explosives and some agricultural wastes are subject to separate regulatory provisions. Guidance on which mine and agricultural wastes should be treated as controlled waste is given in DoE Circular 11/94 (Welsh Office Circular 26/94).

The general definitions of waste and particular waste types are given in more detail in the Environmental Protection Act 1990, the Control of Pollution (Special Waste) Regulations (SI 1980 N° 1709) and discussed in the Department of the Environment Circular 24/92 (Welsh Office Circular 30/92) on controlled waste. There are currently proposals (*The hazardous waste Directive, the special waste regulations 1995*) to change the definitions of waste categories, which are due to be implemented in 1995.

This briefing note includes consideration of the following as waste disposal sites: waste transfer stations; scrap yards; bailing plants; recycling plants; solvent recovery plants; waste treatment plants; incinerators; and disposal of sludge to land.

Although sewage sludge is not technically defined as controlled waste when disposed of in a beneficial manner to agricultural land, it is considered briefly in this note to complement disposal by incineration. (Disposal at sea is no longer a long-term option). Landfill sites are not discussed in detail as relevant guidance exists on landfills in the context of the restoration of mineral extraction sites. The latter guidance does not consider landfill development on green field sites; the general impacts of development on such sites are covered by other guidance on general construction activity. In addition, this note does not specifically address the disposal of radioactive waste.

The EA of waste treatment and disposal sites is discussed in some detail by Petts and Edujee (1994) and CIRIA (1994). Waste Management Papers may be relevant to specific types and waste and to facilities. The NRA policy with respect to the protection of groundwaters is available (NRA 1992).

## 2. Development control

The development control of waste disposal sites is within the Town and Country Planning framework. Under the recently consolidated General Development Order the NRA is a statutory consultee for "development involving the use of land for the deposit of refuse or waste" and "development relating to the retention, treatment or disposal of sewage, trade waste, slurry or sludge..". Planning Policy Guidance PPG 23 on *Planning and Pollution Control* provides further relevant information.

## 3. Environmental Assessment

Environmental Assessment may be required for waste disposal sites under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199). Developments on Schedule 1 of the Regulations for which EA is mandatory include:

- "a waste-disposal installation for the incineration or chemical treatment of special waste";
- "the carrying out of operations whereby land is filled with special waste, or the change of use of land (where a material change) to use for the deposit of such waste"; and
- "an installation designed solely for the permanent storage or final disposal of radioactive waste".

Waste disposal related development listed under Schedule 2, i.e. those requiring EA where significant impacts are expected, include:

- "an installation for the disposal of controlled waste or waste from mines and quarries, not being an installation falling within Schedule 1";
- "a waste water treatment plant";
- "a site for depositing sludge",
- "the storage of scrap"; and
- "modification of development listed under Schedule 1".

Government guidance on the Regulations (DoE Circular 15/88 and DoE 1989a) with respect to identifying which Schedule 2 projects do require EA suggest a threshold capacity of 75,000 tonnes a year for installations, including landfill sites, for the transfer, treatment or disposal of household, industrial and commercial wastes. The guidance also suggests that "Except in the most sensitive locations, sites taking smaller tonnages of these wastes, Civil Amenity sites, and sites seeking only to accept inert wastes (demolition, rubble, etc.) are unlikely to be candidates for EA". However, significant impacts may occur from developments not meeting the suggested criteria and EA should still be considered.

HMIP may be able to provide relevant guidance on the need for EA and EA methodologies.

## 4. NRA licences

Waste management developments may require a number of licences from the NRA, such as:

- **discharge consent** - for a discharge to groundwaters, inland and coastal surface waters;
- **abstraction licence** - for abstraction from groundwater or surface waters;
- **impounding licence** - for impounding surface waters; and
- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

## 5. Major potential impacts

Waste management sites will have many general impacts common to a variety of types of operation, and a number of process-specific impacts. In this context depots, waste transfer stations, scrap yards, bailing and recycling plants are combined under the heading of waste handling. Solvent recovery plants, waste treatment plants, incinerators and sludge to land are considered more specifically and may have impacts additional to those from waste handling. The impacts of operations are discussed below; impacts arising from the construction of waste management sites (e.g. from land take, site preparation etc.) is discussed in other guidance.

### 5.1 Waste handling

A major potential impact is that of the pollution of surface (or ground) waters arising from runoff and spillages, leading to reduced water quality and associated impacts on fish, other aquatic life and water resources. The aesthetic (and chemical) quality of watercourses may also be affected by solid wastes (e.g. litter) entering watercourses via windblow or runoff. Fine particulates and poorly (water) soluble contaminants may contaminate stream sediments. Both major spillages and gradual leakages from sites may result in the long-term contamination of the both land and groundwaters. The lining of sites, e.g. by the laying of an impermeable base of concrete, will protect groundwater resources from such damage but there may be a loss of infiltration to underlying aquifers.

Site activity, machinery, vehicle movements, and the sound of vehicle reversing warning sirens, may disturb wildlife and recreational users of watercourses.
Waste handling sites may detract from landscape quality.

Infrastructure associated with waste handling sites, e.g. sewers, power and water supplies, may have impacts beyond the site boundaries and should also be considered.

## 5.2 Solvent recovery plants

Spillages of solvents may be particularly damaging to surface water quality ecosystems. In addition, groundwaters may be particularly vulnerable to solvent contamination, causing long term damage to water resources.

## 5.3 Waste treatment plants

The potential impacts of waste treatment plants will vary according to the waste treated and treatment methods. Surface or groundwater pollution are likely potential impacts.

## 5.4 Incinerators

Thermal discharges, e.g. of cooling water, may cause temperature stress on aquatic ecosystems and alter fish and other ecological communities. Temperature increases may also have secondary effects such as altering concentrations of dissolved oxygen, unionised ammonia and other ecologically relevant substances. Discharges of cooling water may contain biocides and other potentially polluting contaminants.

Abstraction of surface waters for cooling may cause problems of low flow, damaging ecological systems, and mortalities of fish and other life by impingement at intakes.

Aqueous discharges may arise (other than cooling water) from processes such as the dewatering of waste with a high moisture content (e.g. sewage sludge) and aqueous scrubbing of air emissions. Such discharges may contain highly polluting contaminants, depending on the nature of wastes and incineration processes. Discharges may have both impacts on surfaces waters from direct discharge or indirectly via sewage treatment.

Incinerators, particularly emission stacks and gaseous emissions themselves may have particularly significant impacts on landscape quality.

Gaseous emissions may also ultimately damage aquatic and other ecosystems from the settling of contaminants and from effects of acidification. Certain organic contaminants, such as PCBs, may be liable to bioaccumulate within ecosystems, thus placing predators at particular risk.

Solid wastes such as ash may have impacts on water quality, e.g. from leachate or runoff in handling, storage or disposal. Depending on the nature of the waste incinerated, ash may contain high concentrations of certain contaminants, such as heavy metals. The content of metals in sewage sludge will generally vary according to the proportion of industrial discharges in the sewage collection catchment.

## 5.5 Sludge to land

The impacts of sludge disposal include contamination of groundwater and surface waters arising from leaching from the sludge. The content of sludge (and its suitability to apply to land) may be very much dependent on the proportion and quality of industrial sewage treated. Direct contamination of surface waters may occur from runoff of sludge, e.g. following heavy rainfall, causing damage to fish and other aquatic life and associated recreation such as angling. Change in plant communities may occur where sludge or runoff comes into contact with such communities. Recreational use of nearby watercourses may also be affected by strong odours.

## 6. Mitigation measures

Strategically, measures to minimize waste production should be adopted including recycling, composting and the use of digesters. Energy generation or heat recovery should occur when wastes are incinerated or digested.

Individual proposals should consider alternative sites and processes (the consideration of Best Practicable Environmental Option (BPEO) may be a requirement for certain development proposals under the EPA 1990).

The proposed location of waste management operations should avoid sensitive areas such as:

- vulnerable aquifers;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- river floodplains, lakes, wetlands and marshes; and
- upland areas of catchments with particular sensitivities.

### 6.1 Waste handling

With suitable precautions, the risks to the aquatic environment may be minimized.

Sites should be distant from receiving rivers or aquifers at risk from pollution; buffer zones should be used if available.

Sites should be constructed on low gradients (i.e. less than 5%) to reduce severity of runoff and drainage requirements.

Sites should be lined with an impermeable layer, e.g. concrete, with carefully designed drainage systems incorporating sediment traps, grease separators (interceptors), and drainage storage tanks with sufficient volume for runoff, spillage and fire water.

On site, covered bays should be installed in transfer stations and in storage areas etc. to reduce rainfall-induced generation of leachate from wastes.

Adequate bunding should be installed around liquid waste tanks, fuel and other stores. Bund walls should be protected from collision damage.

Vehicles loaded with liquids should not be left overnight in areas without bunds or similar protection.

Vehicle and container wash down areas should have suitable drainage and collection systems. Drainage water should subsequently be treated.

The risks of spillage should be reduced by the adoption of safe operating procedures. There should be verification of incoming waste types and appropriate separation of wastes to avoid unstable mixtures of incompatible chemicals.

### 6.2 Solvent recovery plants

Storage tanks should be subject to particularly stringent containment, incorporating double lining, leak detection equipment and below ground interception facilities. Also, particular measures should be taken to prevent damage to surface water systems in the event of spillages.

### 6.3 Waste treatment plants

Mitigation options will depend on the types of waste and treatment processes.

### 6.4 Incinerators

Recycling of flue gas scrubber and other effluents and the use of storage/balancing lagoons will reduce or prevent discharges to surface waters. Such storage should be of sufficient capacity for complete containment and lined if necessary to prevent contamination of groundwaters. Effluent may be best disposed of via a specific or general treatment works, e.g. effluent from sewage sludge incinerators may conveniently be treated at the sewage treatment works generating the sludge.

Measures should be adopted to ensure complete combustion, thereby reducing risks of pollution from air emissions, effluents and leaching of solid residues.

### 6.5 Sludge to land

Sludge disposal should follow guidance (e.g. WRc/Silsoe College 1985, DoE 1989b, MAFF 1991) to avoid contamination of groundwaters, surface waters and damage to sensitive sites of conservation interest. Unsuitable weather conditions, e.g. frozen ground or heavy rainfall, should be avoided. Sludge injection may be have a lesser associated risk of problems of surface water pollution and odour.

## 7. Baseline surveys

The surveys required will vary to some extent depending on the nature of the proposed development and site. In each case the methods used should be relevant with respect to timing, methods used and the nature of the development. In general, the following survey types should be regarded as a minimum:

- hydrogeology - location of aquifers;
- water quality of groundwater and surface waters;
- hydrology and drainage; and
- landscape/amenity.

Where rivers are at risk from runoff or other discharges the following surveys should be considered:

- river corridor survey (of wildlife and habitats);
- aquatic ecology, including fisheries; and
- recreational use.

Baseline surveys with respect to incinerators should also consider the where fall-out of air emissions is expected (i.e. on the basis of wind direction etc.).

## 8. Monitoring and audit

Monitoring relevant to the predicted impacts and mitigation works should be carried out. Monitoring data should be periodically reviewed and measures taken should unexpected impacts occur.

## 9. References and further guidance

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

Department of the Environment/Welsh Office (1989a) *Environmental Assessment: a guide to the procedures*. HMSO, London.

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Petts, J. and Edujee, G. (1994) Environmental Impact Assessment for Waste Treatment and Disposal Facilities. John Wiley & Sons Ltd., Chichester.

Ministry of Agriculture, Fisheries and Food (1991) *A Code of Good Agricultural Practice for the Protection of Water*. MAFF, London.

WRc/Silsoe College (1985) *Soil Injection of Sewage Sludge: A code of practice*.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF MINING AND QUARRYING OPERATIONS

## 1. Introduction

This guidance note seeks to identify the potential impacts of mining and quarrying operations upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of mineral extraction schemes. The NRA has a interest in such projects due to its environmental responsibilities and particularly with respect to those for water quality, water resources and conservation. Formal EA may be required under planning legislation. Where an EA is not required, environmental information may still be required by the planning authority and other interested parties, including the NRA. The NRA are statutory consultees for developments involving or including mining operations and are also the licensing authority for water abstraction and other relevant issues. An EA is often a useful way of presenting the environmental information required to
process planning and licence applications.

The responsibility for carrying out an EA lies with the developer. The conclusions reached in an assessment require proper justification and the raw data upon which such conclusions are based should be accessible to interested parties. It is a distinct advantage to consult with the NRA and initiate the EA process in advance of detailed plans, such that environmental constraints and mitigation opportunities are recognized at an early stage and there is the proper consideration of alternatives.

Mining and quarrying proposals should have due regard to Mineral Plans produced by Mineral Planning Authorities and Mineral Planning Guidance issued by the DoE. In this document, both mining and quarrying are implied by the use of the term of mineral extraction.

Mineral extraction is often a precursor for other schemes relating to the after use of sites, e.g. for landfill. Such further development is considered by other NRA guidance.

## 2. Development control

Mineral extraction falls under the Town and Country Planning framework. Planning permission may include conditions with respect to the restoration and aftercare of mineral workings. Boreholes drilled in connection with proposed mineral extraction may also require planning permission.

## 3. Environmental Assessment

The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199) cover various types of extractive industry as Schedule 2 projects, i.e. for which a formal EA is required where significant environmental impacts are expected. The types of industry listed in Government guidance on these regulations (DoE/WO 1989) are presented as Appendix 1 of this note. The guidance indicates the scale or location of operations expected to have significant impacts.

This note concentrates on the extraction of solid minerals and includes underground and opencast mining. Quarries can in many respects be regarded as open-cast mines for non-energy producing minerals. Extraction of aggregates on large scale from coastal sites, the so-called "super quarries", are not specifically considered here as proposals for these have concentrated on Scottish sites. Also, excluded from this guidance is consideration of the dredging of aggregates from marine sites.

EAs may also be required for installations for the disposal of wastes from mines and quarries.

## 4. NRA licences

The NRA is the licensing authority for the following:

- **discharge consents** - for discharges to all controlled waters (i.e. groundwaters, inland and coastal surface waters);
- **abstraction licences** - for water abstraction from groundwater or surface waters;
- **impounding licences** - for impoundment of surface waters; and
- **land drainage consents** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Permission to discharge must be obtained prior to operation

## 5. Major Potential Impacts

Impacts are presented largely for the operation of mines and quarries. Site investigation or prospecting activity may have some minor impacts from the transportation and access of drilling machinery and operators, and site works such as borehole drilling itself. These are not discussed further, but may need to be considered. Construction activity such as to prepare the site are considered briefly. For more information on the impacts arising from the general construction of access roads, site buildings etc., refer to other NRA guidance. Similarly, the restoration of mineral extraction sites, e.g. for landfill or recreational use, is covered in detail by separate guidance. The processing of materials from quarries or mines may be performed on site and may have a variety of impacts. NRA guidance on general industry may be applicable, as may guidance from the DoE on specific processes subject to the Environmental Protection Act 1990.

### 5.1 Construction

Site works may include clearance of the ground surface for access roads, vehicle parks, buildings, process works or for mining itself. Ground clearance will extend to the removal of soils and overburden in areas to be mined/quarried. The principal impacts of ground clearance will be ecological and hydrological. In addition, clearance may disturb or destroy items of archaeological interest.

Ecological impacts from ground clearance will arise from the direct destruction and removal of vegetation and soil structure. The storage and disposal of soil and overburden may also smother habitats. Indirect impacts may arise from hydrological changes and pollution. Soil compaction from vehicle movements and storage of overburden may also affect the long-term recovery of sites.

Hydrological impacts will arise from the loss of the moisture holding capacity of overlying soils and vegetation, and runoff resulting from cleared ground. Runoff may carry high sediment loads into receiving watercourses, affecting water quality and stream ecology. Sediment may damage stream life by direct abrasion and smothering or indirectly from the turbidity cutting out light and settlement of sediment altering substrate composition. Of particular concern to the NRA may be the siltation of gravel areas used by spawning salmon and trout.

Mounds of soils and overburden may be further sources of particulates. In addition, due to exposure of mineral layers to air, leachate from overburden may pollute receiving streams with chemicals such as acids and metals. Disturbed soils may also be significant sources of nitrates released by mineralisation. Nitrates entering watercourses may have impacts on water resources (via drinking water quality) and cause eutrophication, i.e. excessive plant or algal growth

Increased stream flow from runoff may cause stream habitats to become unsuitable for some organisms and may cause erosion of streambed and banks. Stream flows may be reduced in dry periods due to the loss of seepage from the formerly overlying soils and alterations to the water table (see below). Where sites of mineral extraction are extensive, e.g. opencast sites, streams may need to be diverted and site drainage installed. This will destroy or damage established communities and river geomorphology. New channels will have an altered ecology, hydrology, geomorphology and stability. Receiving watercourses may be impacted by siltation and/or pollution.

The site of operations may restrict public access and also affect the local landscape.

## 5.2 Operation

The extraction process will generally involve wholesale removal of the ground surface or overburden (e.g. in opencast mining or quarrying) with the loss of conservation and/or archaeological interest, or more selective extraction of mineral and ores from deep mines. Both processes will generally involve dewatering of working areas. Water pumped from the mine or quarry may be polluted by various contaminants, dependent on the geology of the site and mining operation and may affect the water quality of receiving watercourses and subsequent uses of such watercourses (e.g. for livestock watering). Common constituents of minewater discharges include: suspended solids, iron, ammonia, oxygen demand, acidity and alkalinity. The very quantities of water, regardless of quality, may have significant impacts on the hydrology of receiving streams, with implications to channel geomorphology and flood defence. Dewatering may affect groundwater flows and level, affecting water resources. Physical extraction of water-bearing material and any damage to aquifers from the extended lowering of water table and replacement with alternative materials may result in a permanent loss of aquifer capacity and correspondingly reduced water resources. Temporary or permanent lowering of the water table may have severe implications to the flora and fauna of wetlands and spring-fed streams. In addition, adjacent land use (e.g. agriculture) may be affected by changes to water table levels and/or drainage.

General site activity, the movement of vehicles and use of explosives for blasting may generate dust and other particulates that may directly smother flora and fauna, contribute sediment to receiving watercourses and reduce water quality due to suspended solid loads. Such activities may also generate noise and vibration, disturbing sensitive wildlife. Lighting may also disturb wildlife and the landscape. Spills of fuel and oil from vehicles, machinery and on-site storage may affect the water quality of watercourses and groundwater. The latter may be particularly vulnerable to such pollution as a result of mineral extraction, e.g. limestone quarrying, often occurring in areas of important aquifers. The transport of extracted material may also have more distant impacts, e.g. from lorry traffic and spillages in transit.

The storage of extracted minerals and spoil and disposal of the latter may cause further land take and habitat destruction. Runoff and leachate may be particularly polluting of watercourses. For example, exposure to air of pyrite ($FeS_2$) rich materials may lead to the formation of sulphuric acid and iron rich runoff with subsequent deposition of ochreous hydrated ferric oxide in receiving streams.

Spoil heaps may become a significant and usually undesirable feature on the landscape. In addition, the collapse of improperly designed spoil tips can have catastrophic consequences for both human and natural environments. Spoil heaps themselves may be subject to mineral extraction itself where new technologies make reprocessing economically feasible, with impacts similar to extraction from green field sites.

The disposal of spoil to sea may have severe smothering effects at the locality of dumping and in areas of dispersal. The coastal landscape may also be severely affected by such practices.

## 5.3 Processing

The processing of mined or quarried material may cause a variety of impacts, depending on the process. More significant processes will almost certainly be subject to Integrated Pollution Control. Physical grading processes such as pulverizing and sorting of aggregates, and flotation techniques such as used in coal washeries, may result in effluents with high concentrations of suspended solids and other contaminants. Uncontrolled discharges of these to watercourses may cause significant pollution and smothering of aquatic life.

## 5.4 Post operation

Following cessation of mine or quarrying activities, sites may be subject to a variety of treatments with associated impacts. These are discussed in greater detail in other guidance.

**Abandonment** - Abandonment should seldom occur, due to the usual imposition of restoration, i.e. infilling, and aftercare provisions of planning permission. However, abandoned quarries may or may not fill with water on cessation of dewatering activities, depending on surrounding water table levels. The main impact may continue to be the vulnerability of exposed aquifers to pollution from illegal dumping activities, and the loss of water resource from pollution or the removal of aquifer material. Access routes may also be permanently interrupted by excavations. Quarries and gravel pits may be deliberately allowed to flood to create lakes for conservation and recreation purposes.

The cessation of pumping from mine workings upon decommission or abandonment may result in the seepage of minewater into watercourses as the mine fills, with similar pollution as that from spoil tips. Although this is more likely to be a problem in deep mines, it may occur upon cessation of the dewatering of open cast or quarry sites and is discussed more fully in NRA (1994). The quality of water in abandoned mines will general decrease with increasing duration of contact with exposed minerals and the initial discharge of water from flooded mines may be of very poor quality, with serious affects on receiving water quality. Over time the level of contaminants in discharges will decrease due to flushing effects. The discharge point of water from dewatering may be different than that of seepage from flooded workings. As a result, the cessation of pumping from active mines may affect not only the water quality of receiving streams, but also their hydrology. Leachate from mineworkings may also originate from material tipped in abandoned shafts.

**Restoration** - Sites, including spoilheaps, may be restored. Mine shafts and excavations may be infilled with or without imported material, e.g. waste for landfill. Impacts may arise due to the nature of infill material, e.g. from leachate from landfill or mineral-rich spoil. The runoff/infiltration characteristics will affect supplies to receiving streams or groundwaters, and subsequently influence stream hydrology, water quality and water resources. Infill material may alter groundwater flow. The ecology of the restored site will depend on the methods of restoration, e.g. storage and replacement of overburden and topsoil, drainage characteristics and seeding. Landscaping practices will influence visual impact and also site ecology. Some sites, e.g. opencast mines, may be progressively backfilled and restored during operations.

## 6. Mitigation measures

Alternative sites should be considered, although the choice of sites may be determined by the nature of mineral deposits. In general, there should be avoidance of sensitive locations, e.g. important and/or vulnerable aquifers, SSSIs and wetlands. The location of processing, storage and disposal areas should all be considered.

Site activity should be phased to avoid seasonally sensitive areas. Also, certain mining activities, e.g. opencast mining, should be limited during heavy rainfall. Where appropriate, extraction techniques should be used that reduce the volume of waste generated and also the proportion of fine particulates. Secondary uses for waste materials should be considered, e.g. as infill for large engineering projects.

Mine design should consider the long-term future of the site, where possible.

There should be the safe storage of fuel, chemicals and explosives, with adequate bunding for stored liquids.

The on-site use of pesticides should be minimal due to the vulnerability of aquifers and watercourses to pollution. Also, the use of herbicides on soil mounds may affect the long-term viability of seed in restoration.

Dust production on-site may be reduced by dampening down roads, provided there is an adequate water supply and drainage incorporating silt traps, if appropriate.

Dust and dirt production off-site may be reduced by washing down lorries, subject to provisos above, and using sheeting over loads. Haul roads may also be paved.

Lagoons or tanks with adequate storage volume should be incorporated (and maintained) to allow sufficient settling of suspended solids in slurries, process water and runoff. Also, settling devices (e.g. cyclones and thickeners) may be useful to dewater slurries. Even at the construction stage, measures should be installed to collect, treat and discharge runoff and other surface water under agreed consent conditions. Similarly, there should be suitable provision for sewage and other waste water disposal. Site drainage should incorporate oil separators (interceptors), silt traps, wet balancing ponds, reed bed treatment etc., as appropriate.

Discharges from dewatering activities will require consent and treatment if necessary.

Process waters should be recycled to minimize both abstraction and discharges.

The siting and design of tailings/spoil disposal should consider risks of subsidence and collapse. Mounds, including stored material, should be covered or revegetated encouraged to reduce erosion, windblow, and, in the case of revegetation, to improve aesthetic appearance.

Newly created channels from stream diversions, if unavoidable, should be designed to maximize conservation opportunities and should be 'seeded' with material from former channels as appropriate to encourage colonization by similar communities.

There should be advance provision of physical, chemical or biological treatment systems for minewaters. These may not be required until the cessation of mining (and pumping). The forthcoming closure of mines should be discussed with the NRA well in advance.

Sites should be restored to former or other suitable land use. Opportunities should be sought for environmental and recreational enhancement. This may follow an intermediate use (e.g. landfill). Successful restoration often involves careful long-term storage of topsoil and overburden etc. Public footpaths and other rights of way should be re-established and site drainage reinstated. Flooding of sites may provide recreational opportunities and create aquatic habitats.

Mine shafts should be capped to prevent fly-tipping of unknown waste and reduce safety hazards. However, openings for the access for bats should be included at appropriate sites.

## 7. Baseline surveys

A variety of surveys may be required in the EA of a mineral extraction proposal. Of particular interest to the NRA are the following.

**Hydrogeology** - to identify impacts on groundwaters, such as the groundwater flows, the loss of aquifer and recharge capacity and "vulnerable" aquifers as outlined in NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

**Hydrology** - to identify impacts on river flow and implications for flood defence and stream ecology.

**Water quality** - to ascertain current water quality and predict impacts of pollution on water quality and the ecology of receiving waters.

**Ecology** - to identify valuable habitats (e.g. wetlands), communities and species.

**Landscape** - to ascertain the implications of the mine in operation and in restoration.

**Archaeology** - to identify archaeological interests.

## 8. Monitoring and audit

Monitoring of parameters relevant to the predicted impacts and remedial/mitigation works is recommended and may be required . Parameters may include groundwater and surface water quality, river flow, water table level and the rate of plant and animal colonization of restored areas.

## 9. General guidance and references

Due to cumulative environmental impacts, there may be a limit to the number or extent of such developments permissible in an area or catchment.

Construction Industry Research and Information Association (1994) *Environmental Assessment*. Special Publication 96. CIRIA, London.

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Department of the Environment (1995) *Coal Mining and Colliery Spoil Disposal*. DoE, London.

Hester, R. E. and Harrison, R.M. (1994) *Mining and its Environmental Impact*. Issues in Environmental Science and Technology, Volume 1. Royal Society of Chemistry.

National Rivers Authority (1992) *Policy and Practice for the Protection of Groundwater*. HMSO, London.

National Rivers Authority (1994) *Abandoned Mines and the Water Environment*. Water Quality Series N°14. HMSO, London.

Walsh, F., Lee, N. and Wood, C.M. (1991) *The Environmental Assessment of {Opencast Coal Mines*. Occasional Paper 28, Department of Planning and Landscape, University of Manchester, Manchester.

**Appendix 1 Types of Extractive Industry Listed as Schedule 2 Projects** (after DoE/WO 1989)

a) extracting peat

b) deep drilling, including in particular -

   i. geothermal drilling
   ii. drilling for the storage of nuclear waste material
   iii. drilling for water supplies but excluding drilling to investigate the stability of the soilextracting minerals (other than metalliferous and energy-producing minerals) such as marble, sand, gravel, shale, salt, phosphates and potash

(d) extracting coal or lignite by underground or opencast mining

(e) extracting petroleum

(f) extracting natural gas

(g) extracting ores

(h) extracting bituminous shale

(i) extracting minerals (other than metalliferous and energy-producing minerals) by opencast mining

(j) a surface industrial installation for the extraction of coal, petroleum, natural gas or ores or bituminous shale

(k) a coke oven (dry distillation of coal)

(l) an installation for the manufacture of cement

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF RESTORATION OF MINERAL EXTRACTION SITES

## 1. Introduction

This guidance note seeks to identify the potential impacts arising from the restoration of mineral extraction sites upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of restoration schemes for former mineral extraction sites.

The restoration of mineral workings may be for a variety of purposes including landfill, recreation and nature conservation purposes. In addition, workings may simply be restored systematically to pre-mining conditions as an essential element of the extraction scheme without any intermediate use. This note largely considers secondary uses of mineral workings (e.g. for waste disposal or for recreational purposes) as mineral extraction with systematic restoration is covered by other guidance.

It is the responsibility of the developer to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Proper justification will be required for any conclusions and access may be required to the raw data to examine particular issues in more detail.

## 2. Development control

The restoration of mineral extraction sites will generally be subject to development control under the Town and Country Planning (T&CP) framework.

The use of sites for landfill will also require a Waste Disposal Licence under the Environmental Protection Act (EPA). The NRA is a statutory consultee of the Waste Regulation Authority at the licensing stage. It has the power to object at this stage. More detailed information on NRA policy with respect to landfill applications are outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992).

## 3. Environmental Assessment

An EA may formally be requested under the terms of the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 N° 1199) for the after-use of mineral workings for waste disposal. For general recreation use an EA may not be formally required, but may be requested. An Environmental Statement (ES) arising from EA may be a suitable means of conveying environmental information to the NRA, which may be required before the issues of licences or consents.

Under the Regulations, landfill projects are divided into two types:

- those dealing with "special" waste; and
- those dealing with "controlled" waste or waste from mines and quarries

An EA is mandatory for all landfill applications dealing with special waste, as these projects fall under Schedule 1 of the above Regulations.

For all other landfill projects, EA may be required if they are likely to give rise to significant effects. A threshold of 75,000 tonnes of waste per year is suggested in government guidance (DoE/WO 1989a). If the proposed site is in a sensitive area, then an EA may be requested for smaller projects.

A draft EC Landfill Directive proposes to subject all landfills to EA. The DoE criteria, therefore, should be considered a minimum for future requirements.

## 4. NRA Licences

Development schemes may require the following licences and consents from the NRA.

- **discharge consent** - for the disposal of runoff, either directly, or after treatment, into any controlled water (i.e. groundwaters, inland and coastal surface waters).
- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Examples include proposals to divert or culvert watercourses. NRA consent is also required for obstruction to or infilling of the floodplain under local byelaws.
- **abstraction licence** - for pumping or lowering of the water table. Consent is required for test and monitoring boreholes.
- **impounding licence** - to impound water.
  **fisheries consent** - for the introduction or stocking of fish into an inland water (required under Section 30 of the Salmon and Freshwater Fisheries Act 1975).

The NRA will object to proposed landfill projects unless it can be shown that uncontrolled migration of leachate and deterioration in the quality of local water resources will not occur. Applications will generally be unacceptable in the vicinity of vulnerable and important aquifers. Reference should be made to the NRA 's *Policy and practice for the protection of groundwater* (NRA 1992) and the NRA Position Statement *Landfill and the Water Environment* (NRA 1995).

## 5. Potential Impacts

Impacts are divided into construction and operational impacts for both landfill and water recreation developments. General principles from these should be drawn for other schemes.

### 5.1 Landfill

#### 5.1.1 Landfill construction

The construction of a landfill will generally involve the laying of a synthetic membrane and/or an engineered clay or bentonite amended soil, in order to contain leachate and landfill gas within the installation. Prior to laying, the void created by mineral extraction will generally need to be landscaped with soft material to a substrate upon which the liner system is constructed. A drainage and collection system will generally be laid within the lined void to control leachate.

Vents for the discharge of methane and other landfill gas also may need to be installed. As such, the impacts of landfill construction at recently abandoned mine workings may be minimal, the main impacts of excavation, construction of access roads and other infrastructure having occurred in mineral extraction itself. Where sites have been abandoned for longer periods and ecological communities and recreational use of a site have become established, the preparation of the site for construction may have a variety of impacts including the following.

**Loss of habitats** - In most instances, all habitats within the former workings may be destroyed by landfill construction and operations.

**Drop in water table level** - Dewatering of flooded sites will destroy aquatic communities, and may lower surrounding groundwater levels, affecting wetland sites and drainage. Water resources may be affected and the rights of other licensed abstractors compromised.

**Pollution** - Water pumped from the site may have water quality impacts upon receiving watercourses. There may also be hydrological effects from the water flow.

**Loss of recreational use** - Recreational use of the site, e.g. for walking or water sports, will end.

**Loss of floodplain capacity** - the isolation of sites by undersealing and subsequent infill could result in a loss of floodplain capacity.

### 5.1.2 Landfill operation

The potential environmental impacts from landfill operation are dependent on:

- locational factors (principally hydrogeology);
- waste composition (this may vary over time);
- rate at which the waste is to be deposited; and
- other operational/management factors.

Of primary concern is the contamination of groundwater and/or surface water by leachate. Other impacts relate to the quantity and quality of surface waters, ponds and streams and effects on groundwater flow. Impacts due to the generation and migration of landfill gas, although important, are usually only indirectly relevant to NRA responsibilities. However, gas build-up in sewers receiving leachate may present an unacceptable risks of explosions with consequences for the environment.

#### a) Leachate pollution

Leachate production may be unavoidable. The composition of leachate will vary according with the composition of waste itself, the age of landfill, the extent to which rainfall is permitted to enter the landfill and a number of other factors. Leachate is usually a noxious substance, with significant concentrations of ammonia, organic compounds, chloride and earth metals.

**Groundwaters** - Where a landfill is ineffectively contained, leachate may pollute groundwaters.

Depending on the type and extent of contamination, this may lead to long-term sterilization of both current and future potable supplies. Other users of groundwater or spring abstracted waters may also be affected. Failure or rupture of liners may cause serious groundwater and surface water pollution.

**Surface waters** - Effects on surface waters receiving untreated leachate via contaminated baseflow or runoff may include organic enrichment with oxygen depletion, causing mortalities of fish and other aquatic life, and unaesthetic growths of sewage fungus. Suspended solids, sewage fungus and deposits of iron hydroxide may cause smothering of the substrate, affecting plants, invertebrates, fish and fish spawning. Other contaminants (ammonia, metals and pesticides) may also contribute to significant effects.

The NRA will specify the range of parameters permitted in the discharge of leachate and timing of the discharge as part of the consent conditions.

**b) Other pollution**

Pollution of water bodies, aquifers and drains may also result from spillage of inappropriately stored site fuel, lubricating oils and chemicals. Litter from landfill operations can cause obstructions in watercourses resulting in an increased risk of flooding and aesthetic deterioration.

**c) Effects on groundwater flow**

A contained landfill extending below the water table may present an impermeable barrier to groundwater and may modify the direction of natural flow. This may cause springs and wells to dry up, resulting in a derogation of existing rights.

**d) Recreation and amenity**

Noise, odour and visual disturbance may have effects upon the recreational uses of adjacent watercourses. Any visible forms of pollution such as litter and suspended solids will detract from visual amenity. Public rights of way may need to be diverted.

**e) Conservation and wildlife**

Aquatic fauna may be directly disrupted due to landfill activities. However, the primary cause for concern are secondary impacts as a result of leachate percolation into groundwater and surface waters and alterations in flow as a result of any abstractions. Landfill gas may affect plant life. Gulls, crows and vermin populations may benefit from the landfill; their increased populations may have impacts on other wildlife. Gull faecal production may adversely affect the water quality of (aquatic) roosting sites. Litter blown from landfills may be a hazard to wildlife and have a visual impact.

### 5.1.3 Landfill restoration

Impacts associated with restoration and aftercare could be a major issue. If not properly sealed, old sites may continue to pose a threat to groundwater and surface waters, and cause long-term quality problems. Under the EPA 1990, monitoring and control of landfills remains the responsibility of the landfill operator after disposal operations have ceased, the site has been restored, and until such time as the wastes no longer pose an environmental threat.

Landfills are generally capped with an impervious clay layer to reduce infiltration of rainfall, percolation and leachate production. Surface runoff from such capping may alter the hydrological characteristics of receiving streams, with potential implications for stream ecology and flood defence. Runoff effects may be exacerbated where landraise occurs. Landraise and surface structures, e.g. gas flares or recovery equipment may also significantly alter the landscape.

The contaminated nature of restored landfill sites may restrict future uses of the land. Sites may also be subject to subsidence.

## 5.2 Water recreation sites

### 5.2.1 Construction

Sites for water recreation will generally require landscaping of the site of the lake or lakes and surrounds, and the construction of access ramps, mooring facilities and buildings etc., depending on proposed activities. Lining of lakes may be required to guarantee water levels, or to isolate sites from the water table and/or underlying minerals and mineral waste. Dewatering of sites prior to lining may have implications on the water quality and flow of receiving waters.

#### a) Landscaping

Soil excavation may destroy established communities. The planting of sites with seeds, shrubs and trees may lead to the introduction of unsuitable, often non-native species that may alter the ecology of the site. Where dewatering of lakes is required to access submerged areas, aquatic life may be adversely affected. The discharge of water may have impacts on receiving streams. Drawdown of the surrounding water table may occur with impacts on wetlands, drainage and water resources.

#### b) Lake filling

The flooding of mineral workings may have a number of impacts.

**Water resources** - water used to fill the lake will be unavailable elsewhere, and may be subject to competing demands.

**Water quality** - the quality of lake water may be adversely affected by underlying minerals and mineral and other wastes. Nutrient-rich water may be subject to algal blooms. Oil residues may produce unsightly films on the water surface. Visiting gulls from nearby colonies may add to the concentrations of nutrients and bacteria. Watercourses and groundwater may be affected by drainage from filled lakes.

**Habitat loss** - terrestrial and riparian habitats may be destroyed by immersion. However, new habitats will be created.

**Loss of flood storage** - the filling of the lake may represent a loss of flood storage.

### 5.2.2 Operations - recreational activity

Recreational activities may themselves have a variety of impacts, depending on activity types, which may include windsurfing, sailing, rowing, scuba diving, jet skiing, water skiing, and angling.

**Recreation** - Conflicts between recreational users may occur, e.g. speed boats may disturb anglers, wind surfers etc. Patterns of recreational use in the surrounding area may also change with the development of new facilities, thus affecting other sites.

**Water quality** - Water quality may be affected by pollution from fuel spillages from powered craft, fuel stores and car parks. Inadequate sewerage provisions at clubhouses, public conveniences etc. may result in sewage pollution. Water quality of the lakes may determine suitable uses, i.e. water contact sports may not be permitted.

**Conservation** - Wildlife may be affected by general activity and noise from speedboats, jet skis etc. Disturbance may be particularly significant at certain times of year, e.g. breeding or wintering birds. However, lakes will also represent new areas of aquatic habitats.

**Fisheries** - Fish introduced from lakes may escape into nearby watercourses, potentially altering fishery quality and ecosystem functioning. The transfer of fish diseases may also occur.

### 5.3 Nature reserves

Abandoned mineral working may be colonized by a variety of wildlife and warrant conservation measures. Impacts from the restoration of sites as nature reserves will generally be minor but may include the following.

**Conservation** - Disturbance of sensitive species, from noise, general activity, trampling and vandalism. Loss of species from land take for paths, buildings and car parks.

**Water quality** - Oil pollution from car park areas, sewage pollution from inadequate toilet facilities. Fly tipping and the deposition of litter may cause water quality and aesthetic problems.

## 6. Mitigation measures

### 6.1 Landfills

Developers should follow advice given in Waste Management papers (e.g. DoE 1986, 1993, 1994).

a) **Location and design** - Landfill may not be a viable option where sensitive aquifers or watercourses are at risk. The distance between the landfill and the receiving water should be sufficient to allow any leakage from containment systems to be diluted, dispersed or attenuated. Landfill design should be modified to avoid sensitive habitats in quarries, although translocation of important species may also be a possibility.

b) **Waste type** - Inert waste will be less likely to generate noxious leachate.

c) **Waste minimization** - The minimization of waste production, e.g. by recycling, will reduce the need for landfills and resulting environmental impacts.

d) **Sealing the site** - The site should be adequately sealed.

e) **Good management practice** - Methods of working should consider implications for leachate production and other impacts. It is recommended that one cell is filled at a time to minimize the areas open for leachate generation, and that waste is compacted to prevent infiltration of water. Completed areas should be covered with impermeable materials. Rainfall on virgin areas should be directed from the site without contact with the waste. Perimeter fences will reduce litter contamination from windblow.

Lubricating oil, site fuel and other potential pollutants should be stored in sealed tanks or containers with secure, impervious bunds. The volume of the bund should be in excess of that required to contain the contents in the event of an entire spillage. All valves and taps should be positioned within the bund.

Wheel washing facilities should be utilized (with suitable treatment of washings).

g) **Capping** - Landfills should be capped after operations cease in order to prevent ingress of surface water.

h) **Treatment of leachate and surface runoff** - Leachate should be contained and collected prior to disposal to sewer. Surface runoff treatment may incorporate a combination perimeter drainage, balancing lagoons, silt traps and reed bed treatment.

I) **Floodplain impacts** - Compensatory work may be required to mitigate loss of floodplain storage.

j) **Vermin control** - may be required.

### 6.2 Water recreation

In general, guidance in Planning Policy Guidance (PPG) 17 *Sport and Recreation* may be applicable. The following deals with specific issues.

**Lake design** - Lakes should be designed to incorporate or replicate important habitats in the abandoned mineral workings, if these had become valuable aquatic habitat. Islands created by mounds of topsoil/overburden may be useful additions to lake design, providing nesting and roosting habitats for birds. Submerged islands may also be useful aquatic habitat. Translocation of species between similar habitats may be an option.

**Water quality** - If appropriate, lakes should be lined to prevent continuation with groundwater or surface water, e.g. where lake water may adversely affect nearby rivers and {vice versa}.

**Zoning of activities** - Conservation interests may be protected by the zoning of disturbing activities both temporally and spatially. Certain activities may best be banned altogether.

**Selective stocking/planting** - The choice of fish stocked should consider compatibility with nearby watercourses. It may be appropriate to design lakes such that they actually contribute to river fisheries, e.g. by providing spawning and nursery areas out of the main river flow. Planting and seeding should consider the impact on existing ecology.

**Flood storage** - There may be opportunities to manage the water levels of the lakes such that they may be used as flood storage areas - reducing flooding downstream.

### 6.3 Nature reserves

Measures will depending on the importance, location of species and their sensitivity, and may include access restrictions, the installation of paths and hides. In sites of relatively low conservation but high scenic value, public access may be actively encouraged, and facilities such as public conveniences and children's play areas installed. Safety provisions may be required where visitors may be at risk from rockfalls, path subsidence etc.

## 7. Baseline surveys

The surveys required will depend to some extent on particular restoration plans and availability of information gathered in the planning and monitoring of mineral workings. In general, the NRA will require a thorough hydrogeological survey of the site and surrounds with an assessment of impacts on water resources of any stretch of river likely to be affected. In addition, the following surveys may be required, where appropriate, using recommended techniques:

- catchment drainage pattern and hydrology (including flood patterns and levels);
- details of the floodplain flow and storage pattern;
- soils;
- groundwater and surface water quality;
- aquatic flora and fauna;
- river corridor survey;
- downstream water uses and recreation;
- landscape;
- fisheries;
- archaeology; and
- climatic conditions (e.g. rainfall, wind strength and direction).

## 8. Monitoring and Audit

An appropriate monitoring strategy should be developed, based upon initial findings and the predicted impacts of the project. Monitoring may determine if steps are necessary to contain, reduce or avoid unanticipated impacts. Detailed monitoring is likely to be required for landfill sites.

### Landfill sites

For landfill sites, the NRA wish to see the following incorporated into any monitoring programme:

- the amount and composition of runoff;
- the quality and levels of leachate;
- any discharges into watercourses; and
- the quality of the receiving groundwater.

Current practice is for the placement of boreholes to indicate water levels:

- in the tipping cell;
- on site (but not in the cell); and
- adjacent to the site.

The NRA will make recommendations as to the design and placement of monitoring boreholes within the site and its surrounds, to monitor groundwater composition and flow.

Boreholes should be inspected regularly as part of an agreed monitoring strategy. This should continue after operations have ceased as leachate generation may continue for many years.

### Water recreation sites

For water recreation sites, suggested monitoring may include water quality, and surveys of both breeding and wintering birds.

## 9. References and guidance

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF ROAD AND ROAD WIDENING SCHEMES

## 1. Introduction

This guidance seeks to identify the potential impacts of road and road widening schemes upon the water environment. It is intended to form the basis of a fairly detailed general scoping brief to cover the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of road schemes.

It is the responsibility of the developer to carry out the EA and to present the results in an appropriate manner to address the questions raised by the NRA. Reference should be made to the *Design Manual for Roads and Bridge - Volume 11* (DoT 1993). In addition, Volume 10 of the design manual provides advice on sympathetic environmental design, particularly documents making up the so-called "Good Roads Guide".

Proper justification will be required for any conclusions and access to the raw data may be required to examine particular issues in more detail.

## 2. Development control

For the purposes of development control, road schemes fall into two separate categories. The Secretary of State for Transport and the Secretary of State for Wales are the highway authorities for trunk roads and motorways. These are approved under procedures set out in the Highways Act 1980. Statutory orders are published which are usually subject to a public inquiry. Other roads developed by local authorities and private developers require planning permission and follow the normal planning procedures within the Town and Country Planning framework.

## 3. Environmental Assessment

Roads appear on both Annexes of the EC Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EEC). Annex I includes "motorways and express roads" and Annex II includes roads as "roads (not listed in Annex I)" and widening schemes etc. ("modifications to development projects included in Annex I).

Translated into UK law, an EA should be undertaken by the Department of Transport under Statutory Instrument 1988 No 1241 for any trunk road or motorway encompassed by certain threshold criteria of size. These are where the road is either over 10 km in length or is longer than 1 km, where the route passes through a "sensitive area" (DoE/WO 1990). Trunk road improvements will also require an EA where they are likely to give rise to "significant effects", having regard to the criteria set out in DoE Circular 15/88 (WO 23/88).

Roads developed by local authorities and private developers may require an EA as these are listed as Schedule II projects under Statutory Instrument 1988 N° 1199, again based upon criteria of significance outlined set out in DoE Circular 15/88 (WO 23/88). Private toll roads and other "special roads" require an EA as Schedule I projects under these Regulations.

## 4. Interpretation of the Regulations

The thresholds are widely accepted as being very high. Developments below the size criteria can still have a serious environmental impact. Such is the detrimental nature of some road projects on the aquatic environment that the NRA wish to be involved in the screening of projects and would indicate whether an EA is required. Location is an important factor and, in line with its general environmental duties, the NRA are likely to require an EA under the following circumstances:

- where valuable river, wetland or lakeland habitats are likely to be destroyed or impoverished or where there are major modifications to a river channel or corridor;

- where pollution arising from construction activity or as a consequence of increased risk and vulnerability might have a significant impact on water quality or cause a breach in water quality objectives;

- for developments likely to have a significant impact upon the availability of water resources or upon groundwater quality or quantity; and

- for developments in the headwaters or for developments likely to cause a significant increase in flood risk.

## 5. Road routing and the assessment of alternatives

The NRA wish to be involved in the assessment of any proposed road projects from the initial "scoping" stage, prior to the selection of the proposed alignment. Early involvement will enable environmental constraints to be identified and sensitive areas to be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. The NRA can also indicate opportunities for environmental improvements at an early stage.

Examples of sensitive areas include:

- river floodplains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological, recreational or amenity value;
- rivers supporting valuable fisheries;
- contaminated land likely to lead to polluting runoff;
- important aquifers;
- river abstraction points; and
- upland areas of catchments with particular sensitivities.

## 6. NRA Licences

Road schemes are likely to require the following licences and consents from the NRA.

i. **Land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Examples include the construction of bridges, outfall structures and culverts or river diversion. Local byelaws may also forbid obstruction or infilling the floodplain without consent.

ii. **Abstraction licence** - for water abstraction, including dewatering.
iii. **Impounding licence** - for any impounding of water, e.g. creation of artificial ponds and lakes.

Land drainage and impounding licences must be obtained in advance of any construction, regardless of whether planning permission has been granted. Land drainage consents are issued under Section 109 and 110 of the Water Resources Act 1991 for designated main rivers. For non-main rivers, this is covered under Section 23 and 24 of the Land Drainage Act 1991. Local authorities and Internal Drainage Boards (IDBs) also have responsibilities for the latter.

Although discharges of drainage from highways are generally not subject to **discharge consents**, a highway drain may become subject to a prohibition notice under Section 86 of the Water Resources Act 1991 if the NRA and road developer cannot reach an agreement on appropriate pollution prevention measures. If an effluent is discharged in contravention of the prohibition, and a similar contravention is likely, the NRA may serve a discharge consent upon the person who has caused or permitted the contravention (Luker and Montague 1994).

## 7. Major Impacts

Impacts on the aquatic environment may arise as a result of construction activities or due to the operational end state of the development.

### 7.1 Construction impacts

The main impacts of construction will arise from primary engineering works e.g. embankments, cuttings, bridges and tunnels. Alignment of roads through valuable river corridors, stream diversions, and the insensitive design of bridges and embankments can result in the destruction or impoverishment of river corridors with consequent impacts upon conservation, recreation and amenity. Other associated construction works, such as slip roads, new junctions, temporary haul or access roads, service areas, filling stations, temporary accommodation for workers and the installation of electricity supplies will add to the impacts, if only through added land take. Brookes and Hills (in press) discuss some of the impacts of road developments on river corridors.

#### 7.1.1 Embankments and cuttings

The excavation and disposal of soils will result in the direct destruction of habitats with resultant effects on flora and fauna. Even with reinstatement measures, secondary adverse ecological effects may arise from the severance of habitats, the spread of weeds and opportunist species with spoil, and from water table and micro-climate changes arising from embankments and other structures. Construction noise and lighting may disturb wildlife. Dust may damage vegetation.

Embankments and other structures in floodplain areas may result in the loss of flood storage. The installation of embankments, cuttings and drainage may alter the drainage to groundwater and surface watercourses. Drawdown of groundwater may also arise from dewatering operations and from cuttings severing shallow aquifers. Changes to water table levels may have secondary effects on wildlife, water supplies and the integrity of the foundations of buildings. Significant alterations to river flow may lead to ecological impacts, altered sediment quality, and other geomorphological changes.

The water quality of runoff and site drainage may be affected by suspended solids, oil and construction materials. Additional pollution of surface or groundwaters may occur where contaminated land is disturbed or from contaminated groundwater drawn into the site by dewatering operations. Leachate from imported or excavated material may pollute groundwater or surface waters.

Excavation in river floodplains or river diversion may uncover archaeological remains. It is important that arrangements are made to contact the County Archaeologist to establish any risk of damage and need for the removal or preservation of any findings.

The construction and use of the road will have impacts on the landscape, with embankments and flyovers being particularly noticeable features. It is likely that such a linear development may interfere with established rights of way.

### 7.1.2 Bridges

The construction of river bridges and other in or near channel works (e.g. culverts) may lead to a variety of impacts. Water quality may be affected by disturbance of instream or riparian sediments, dewatering operations and spillages of oil, cement and other construction materials. Raised suspended solids and sedimentation may be particularly damaging to downstream salmonid spawning gravels. The bridge structure and its construction may block the passage of fish, birds and mammals. Navigation may also be disrupted. Culverts should be avoided as they may compromise various functions of a river and its corridor. The flow characteristics of the river may be altered leading to sediment quality and other geomorphological changes. Shading due to bridges or culverts may destroy plant communities.

### 7.1.3 Tunnels

Tunnel construction may impact upon water quality from solids, oil, lubricant and grouting materials entering watercourses. The presence of an impervious tunnel structure may alter groundwater flows. Groundwater quality may be affected by pollution and the mixing of groundwaters at the interface of different strata penetrated by tunnelling. The noise and vibration from tunnelling activities may disturb wildlife.

### 7.1.4 Other works

**Stream diversions** - Stream diversions should generally be avoided as they have serious impacts. These include the loss of established aquatic and riparian habitat and stable river geomorphology, with resulting effects on a wide variety of aquatic and riparian wildlife and altered river flow and sedimentation patterns.

**Accommodation works** - Any temporary accommodation works required for construction workers may lead to water quality problems arising from sewerage and disturbance of wildlife in the locality, both from temporary land take by buildings and noise and light from site activities.

**Installation of electricity supplies** - The installation of cabling for power supplies for lighting overhead and telephone lines may have affects similar to those for pipelines (see relevant guidance note). Other infrastructure requirements such as for water or sewage may have similar effects.

**Vehicle use and storage** - The storage and use of construction vehicles may result in oil contamination of surface or groundwaters. Vehicle movements may also disturb sensitive fauna, particularly nesting birds.

**Aggregates** - The extraction and transport of aggregates will have impacts off-site.

## 7.2 Operation impacts

Major pollution impacts may occur if surface water drainage is not adequately disposed of or as a result of spillages. River flow may be constricted by structures, leading to reduced standards of flood defence and the potential for future flood alleviation to be prejudiced financially. The highway structure may also have an effect upon the catchment runoff response.

### 7.2.1 Drainage and pollution of watercourses

Increases in traffic flow and the associated road construction programme is placing an increasing pressure on the aquatic environment in terms of drainage facilities required. Motorways, in particular, provide long stretches of impermeable surface draining to a single point. Where such points are located at major intersections, there is an increased risk of accidents, spillages and pollution.

Surface runoff is discharged either directly to a watercourse or some form of balancing or soakaway system. There is a significant risk of pollution as a result of the following:

i. **Routine runoff** - Enhancement of background levels of contaminants due to tyre wear, vehicular emissions, oil, litter etc. In particular, runoff may contain significant quantities of suspended solids, polynuclear aromatic hydrocarbons (PAHs), oil, lead, cadmium, zinc and other heavy metals.

ii. **Accidental spillage** - Oil and/or chemicals may be spilt directly as a result of accidents, particularly at major intersections. Indirect pollution may subsequently occur due to the use of fire fighting or clean-up materials.

iii. **Operations and maintenance** - Weedkillers, de-icing agents, clearance and maintenance of ditches and ponds.

iv. **Other** - Atmospheric deposition, vehicle maintenance, illegal disposal and agricultural activities.

Pollution may also continue to arise from leachate from construction fill material, e.g. slag.

Lowering of the water quality, whether gradual or as a result of a specific accident will have direct effects upon the river wildlife, fisheries and general amenity.

Sewerage requirements of buildings associated with the road may overload the existing infrastructure, resulting in reduced surface water quality.

### 7.2.2 Effects on groundwaters

In order to avoid pollution of groundwater, all soakaways and settling ponds must conform to the NRA 's *Policy and practice for the protection of groundwater* (NRA 1992). If road cuttings and tunnels are below the water table, then localized flooding of the road may occur.

The catchment response to rainfall will be altered due to the creation of a large impermeable surface which will reduce infiltration. Large earth movements associated with tunnelling may affect the direction and quantity of groundwater flow. Linking up previously discrete aquifers will cause the water to follow from one to another, thus affecting groundwater levels.

### 7.2.3 Other impacts

Culverts may present a flood risk if these become blocked.

The road may act as barrier to migration of certain wildlife, be it due to the road itself, traffic or embankments etc. Some animals, e.g. amphibians and badgers, may try to cross the road but incur significant mortalities. The course of the road may itself become a wildlife corridor. Land use changes resulting from the presence of the road may bring about further impacts.

Vegetation control may damage nesting birds and other habitats at certain times of year. This and other maintenance activities may disturb wildlife.
The noise and vibration from road traffic may damage historic buildings and may also disturb wildlife.

Sewerage requirements associated with buildings may overload the existing infrastructure, resulting in reduced surface water quality.

The road may lead to consequential development associated with it which may add to the total impact.

## 8. Mitigation measures

Measures which should be taken to mitigate adverse effects will have to be discussed with reference to the project in question, but some of general principles are discussed below. The

Highways Agency (1994) has produced useful guidance for developers that sets out practices that should be adopted to meet NRA concerns. These guidelines should be followed, where possible, for all road developments.

## 8.1 Drainage

Luker and Montague (1994) provide detailed guidance on the control of pollution from highway drainage, which should be followed. The design of drainage systems should incorporate the risk of spillages which may increase at certain points, e.g. major motorway intersections. In general, a number of measures may be adopted to minimize the risk of pollution incidents, including the following.

i. **Oil separators (interceptors) with cut-off valves** - These may be specifically required on roundabout and interchange junction areas and straight carriageways where the receiving waters are particularly susceptible to pollution.

ii. **Silt traps** - Where it is anticipated that large quantities of silt may jeopardise the efficient operation of an interceptor, an upstream silt trap should be provided.

iii. **Wet balancing ponds** - If suitably designed and maintained, these may form a local environmental feature, particularly if vegetated, as well as providing a degree of treatment for polluted runoff.

iv. **Open ditches** - Open ditches may be used in combination with sand bag and wooden booms to intercept a pollutant.

v. **Soakaways** - The depth of soakaways must be restricted in line with the NRA's Groundwater Protection Policy.

vi. **Reed beds** - For treatment of runoff using existing or artificially constructed wetlands. The wetland may provide useful habitat, although the vulnerability of wildlife to pollution and road traffic should be considered.

vii. **Grass swales** - These and other types of buffer zones can provide areas in which the various impacts of roads may be absorbed before reaching watercourses.

It is important to maintain good access and operating instructions in the event of a spillage and for maintenance purposes. Operating instructions/signs should be provided at shut-off valves etc.

## 8.2 Conservation of river corridors

The NRA wishes to promote river corridors as conservation and amenity areas. As such, it is opposed to developments likely to have a detrimental effect on river corridors. Where development does occur, appropriate mitigation measures may be required, such as the following:

i. An adequate river corridor width between the road and existing or proposed river channels. A figure of 50 m from either bank has been widely quoted as appropriate to preserve the continuity of the wildlife habitat. However, this may not be possible in valley situations.

ii. A 9 m minimum (depending upon local land drainage byelaws) width on each bank should be provided beneath bridges and river crossings. Local stone, brickwork or concrete finishing should be selected to blend in with the local environment. Provision for relevant nest and/or bat boxes in bridge structure should be considered. Where appropriate, sufficient headroom under bridges should be allowed for to ensure navigational access not compromised.

iii. If culverting is unavoidable, the length should be kept to a minimum; a freeboard above the top water level should be maintained to allow the free passage of debris unless a trash-grid is installed. Culvert design should be to specific flood return periods and capacities. Reinstatement of the river bed should be carried out with a suitable substrate. A ledge above normal water level should be installed for utilization by mammals.

iv. Careful design of diverted river channels considering both river stability, maximizing nature conservation interests and appropriateness in the landscape.

## 8.3 Other measures

Other mitigation measures that should be considered include:

- using alternative routes to minimize impacts;
- timing of construction to reduce disturbance of wildlife;
- using fencing to stop both the increase of working area and parking outside of that area;
- using bridges and tunnels, rather than cuttings and embankments;
- reinstating cuttings and embankments with appropriate vegetation;
- adopting sympathetic spoil disposal management;
- covering soil/spoil mounds to reduce silt runoff;
- remedial action at contaminated sites;
- habitat creation;
- translocation of species (and soil) from destroyed habitats to suitable sites;
- ensure invasive/alien plant species are not transferred to the site and eliminate transferals if they occur;
- installing appropriately designed tunnels for the safe passage of amphibians, badgers etc. at known crossing points;
- fuel and other stores should be adequately bunded or lined to protect groundwater and surface waters;

- using drip trays for pumps and other machinery;
- fitting design of embankments and cuttings to achieve natural profiles and vegetation cover;
- providing acoustic and visual barriers to protect and shelter sensitive sites;
- providing bridges etc. to maintain footpaths and other rights of way, including access to a river and recreational activities; and
- formulation and adoption of a sensitive management plan.

## 9. Baseline surveys

In addition to a river corridor survey for any channel affected by the development, the following surveys may be required:

- water quality;
- hydrology;
- hydrogeology;
- fisheries;
- botanical/ecological/bird;
- aquatic biology;
- recreation and amenity;
- landscape;
- archaeology; and
- geomorphology

Details of proposed baseline survey work should be discussed with the NRA as soon as possible as parameters are likely to be diurnally and seasonally variable.

## 10. Maintenance

Facilities should be provided for access, and provisions made for regular maintenance of the road and associated developments, and particularly of silt traps and other pollution control devices. The details of these will have to be discussed with the NRA. Maintenance and vegetation control should be conducted at appropriate times of year (i.e. outside of nesting periods). Mechanical methods of control should be used in favour of chemical controls. In the latter case only approved pesticides should be used, particularly near watercourses (in which case NRA consent is required). Appropriate guidance should be followed, e.g. NRA (1995)

## 11. Monitoring and audit

An appropriate monitoring and remedial management strategy should be devised, based upon initial findings and the predicted impacts of the project. Audit may be required in certain cases.

## 12. Further guidance and references

English Nature have produced a report *Roads and Nature Conservation* which includes guidance on impacts, mitigation and enhancement works. The Welsh Office have produced a landscape design guide, *Roads in Upland Areas: Design Guide* (WO 1990). Further Welsh Office guides, *Roads in Lowland Areas: Design Guide* and *Rock Profiling and Vegetation Re-establishment* are in press. The Institute of Environmental Assessment (IEA, 1993) have produced guidelines for the assessment of road traffic.

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NRA (1992) *Policy and practice for the protection of groundwater*. HMSO, London.

NRA (1995) *The use of herbicides in or near water*. NRA (Anglian Region), Peterborough.
Welsh Office (1990) *Roads in Upland Areas: Design Guide*. Welsh Office, Cardiff.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF RAILWAYS

## 1. Introduction

This guidance note seeks to identify the potential impacts of railways upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of railway schemes. Railways may affect a variety of NRA interests and particularly water quality and flood defence. Railway projects will generally be subject to formal environmental assessment procedures and the responsibility for the assessment lies with developer.

There are distinct advantages for the developer to contact the NRA, and also to conduct some of the environmental assessment in advance of detailed planning such that there is a proper consideration of the need for the scheme, alternatives, particularly with respect to routing, and general environmental implications.

## 2. Development Control

Railways are listed in both Annexes I and II of the EC Directive 85/337/EEC and also are on the corresponding Schedules of the Town and Country Planning (Assessment of Environmental Effects) Regulations SI 1988 No. 1199 as "a line for long-distance railway traffic" (Schedule 1) and "a tramway, elevated or underground railway, suspended line, exclusively or mainly for passenger transport" (Schedule 2). However, the planning of most major railway developments would now fall under the Transport and Works Act 1992. Under the Application Rules of this Act an Environmental Statement is generally required, the EC Directive rules applying similarly as for Town and Country Planning Regulations.

## 3. NRA Licences

The NRA may require a variety of licences or consents for operations affecting surface or groundwaters (e.g. for abstraction, discharge, impoundment and land drainage operations). For railway developments the main requirement is likely to be for **land drainage consent** for any works on the bed and banks of a river or construction of any structure (e.g. embankments, bridges) likely to impede the flow. Land drainage licences must be obtained in advance of any construction, regardless of whether planning permission has been granted.

**Discharge consents** may be required for the disposal of runoff to a sensitive watercourse or soakaway system.

## 4. Major/Potential Impacts

### 4.1 Construction impacts

The main impacts of construction will arise from primary engineering works (e.g. embankments, cuttings, bridges and tunnels) and other works such as access roads, station and stabling yard construction, stream and road diversions, accommodation works, and the installation of electricity supplies (where required). The necessity of a relatively straight route of low gradient results in some lack of flexibility in the choice of routes. As a result, the avoidance of meandering river corridors may not be possible and frequent river crossings may be required. he NRA will be particularly concerned about consultation activity in close proximity to watercourses.

### 4.1.1 Embankments and cuttings

The preparation of a rail route would usually entail major earthworks in the creation of raised embankments and sunk cuttings along with levelling before the installation of ballast and the track itself.

The excavation, storage and disposal of soils will result in the destruction of habitats with resultant effects on flora and fauna. Secondary adverse ecological effects may arise from: severance; the deposition of dust; the spread of weeds and opportunist species with spoil; and micro-climate changes arising from embankments and other structures. Construction noise (e.g. blasting) and lighting may disturb wildlife. Excavations may damage archaeological interests.

The raising of embankments may result in the loss of floodplain area and associated flood storage. The installation of embankments, cuttings and drainage may alter the drainage patterns and flow of adjacent watercourses and groundwater. Where significant changes to river flow occur there may be ecological impacts of low flows, altered sediment quality and other geomorphological changes. Changes to water table levels may have impacts on water supplies, building foundations, and wetlands and other habitats affected by groundwater levels.

The quality of receiving watercourses may be affected by runoff and site drainage which may carry raised concentrations of suspended solids, oil and construction materials. Where contaminated land is disturbed further contamination may occur. Aquatic ecosystems including fisheries may be damaged as a result.

The landscape may be affected by both construction and operation of the railway, with embankments being particularly noticeable features. The course of the track may interfere with established rights of way.

### 4.1.2 Bridges

The construction of bridges and other in-channel works (e.g. culverts) may lead to a variety of effects. Temporary measures to accommodate watercourses diverted around bridges or culverts during construction may lead to a raised flood risk over this period (and localized ecological effects). Completed structures may also lead to increased flood risk. Water quality may be affected by disturbance of instream or riparian sediments, dewatering operations and spillages of oil, cement and other construction materials. Raised suspended solids and sedimentation may be particularly damaging to downstream salmonid spawning gravels. Instream structures may block the passage of fish, whilst the more terrestrial elements of the bridge structure may block the passage of birds or mammals. Navigation may also be affected. The flow characteristics of the river may be altered leading to sediment quality and other geomorphological changes. For instance, scour may occur around bridge piers.

### 4.1.3 Tunnels

The construction of tunnels may affect water quality through the entry of suspended solids, oil and lubricant from tunnelling and grouting. Groundwater flows may be affected by presence of an impervious tunnel structure, and quality altered by mixing of groundwaters at the interface of different strata penetrated by tunnelling. The noise and vibration from blasting and tunnelling may disturb wildlife.

### 4.1.4 Other works

**Access roads** - The creation of temporary access or haul roads will result in soil disturbance and compaction along the route. There will be a loss of, and damage to, plant (and animal) communities. Runoff and culverting activities may result in raised suspended solids levels and siltation in watercourses, affecting water and substrate quality. The storage and use of vehicles and fuel may result in oil contamination of surface or groundwaters. Vehicle movements may also disturb sensitive fauna, particularly nesting birds.

The creation of permanent access routes will result in more permanent habitat damage and loss. There may also be drainage effects.

**Stations and stabling yard construction** - Stations, signal box and stabling construction will involve impacts of land take for these and associated car parks and access roads - see general construction guidance note.

**Stream diversions** - Stream diversions may be necessary. The impacts of these are the loss of established aquatic habitat and stable river geomorphology with likely effects on a wide variety of aquatic and riparian wildlife, and altered river flow and sedimentation patterns.

**Road diversions** - Road diversions may be necessary as part of a scheme. (Refer to guidance note on roads and road widening for likely impacts).

**Accommodation works** - Any temporary accommodation works required for construction workers may lead to water quality problems arising from sewerage and disturbance of wildlife in the locality, both from temporary land take by buildings and noise and light from site activities.

**Installation of electricity supplies** - The installation of underground cabling (and overhead wiring) will have effects similar to those for pipelines (see relevant guidance note). Other infrastructure requirements such as for water, telephone or sewage may have similar effects.

**Remote impacts** - The extraction and transportation of aggregates (e.g. for ballast and concrete) and manufacture of track and other construction materials will have impacts off-site.

## 4.2 End state/Operational impacts

In operation, the main general impact of the railway will be from drainage from the track and its corridor. Localized impacts may also occur in association with stations, stabling areas etc.

In general, there will not be a great deal of runoff from a railway itself due to the generally permeable nature of track ballast. Through drainage, however, may be contaminated by oil, spills of cargo, sewage and other train waste, herbicides used for vegetation control and other pesticides. The ballast itself may be a direct source of pollution if it is a waste material. Depending on drainage arrangements, receiving surface or groundwaters may be affected and resources compromised.

Surface water quality may also be affected by pumped (ground) water from cuttings or tunnels, where this occurs.

Through flow of drainage may be rapid and may affect river hydrology with implications for flood defence and sediment transport. Culverts may present a flood risk if these become blocked.

A railway may act as barrier to migration of certain wildlife across it, be it due to the track, railway traffic or embankments. However, the course of the railway may itself become an important wildlife corridor. Vegetation control may also damage nesting birds and other habitats at certain times of year. This and other maintenance activity may disturb wildlife.

The noise and vibration from railway traffic may damage historic buildings and may also disturb wildlife and amenity use of nearby rivers.

Train station, maintenance and stabling areas may cause localized problems. Runoff from buildings will affect the flow characteristics of receiving streams. Drainage of track areas may be at particular risk from oil and other general contamination from trains, and from spills and leaks from refuelling and loading areas. Sewerage requirements associated with buildings may overload the existing infrastructure, resulting in reduced surface water quality.

The railway may lead to consequential development associated with it which may add to the total impact.

### 4.3 Decommissioning

The decommissioning of railways is relatively straightforward. Track, ballast and other components may be removed, but embankments and cuttings are usually retained. Line closure often results in an attractive rural byway with a valuable wildlife corridor.

## 5. Mitigation Measures

Mitigation measures that should be considered include:

- using alternative routes to minimize impacts;
- timing of construction to reduce disturbance of wildlife;
- covering exposed soil/spoil too reduce silt runoff;
- protecting ground on access roads to reduce disturbance of soils;
- transporting materials to site by rail where possible;
- rehabilitating access roads to restore flora and fauna;
- maintaining river corridors by having a minimum width of corridor under bridges, and a

minimum free height beneath bridges;
- using sympathetic bridge material and design, including provision for relevant nest boxes;
- installing culverts with sufficient freeboard (to allow the passage of debris) or with trash-grids, to reduce flood risks;
- making provisions for adequate passage of flood flows in both construction and operational states;
- adequate bunding or lining of fuels, chemicals and other stores to protect groundwater and surface waters;
- installing pollution prevention devices for site drainage (e.g. oil separators, silt traps, balancing ponds), particularly in high risk areas (e.g. loading areas, major junctions); establishing emergency arrangements for spills, including drainage isolation, notification and access arrangements;
- careful siting and storage of soils;
- reinstating cuttings and embankments with appropriate vegetation;
- conducting maintenance and controlling vegetation at an appropriate time of year (i.e. outside of nesting periods) and using approved pesticides, particularly near watercourses; fitting landscaping of embankments and cuttings;
- provision of acoustic and visual barriers to protect sensitive sites;
- careful design of diverted river channels (including replanting) considering both stability and nature conservation interests;
- retaining abandoned river sections as ponds or other aquatic habitats; and
- provision of bridges etc. to maintain footpaths and other rights of way.

## 6. Baseline Surveys

Information should be gathered on a variety of subjects from archive data and field surveys. Surveys should be conducted using appropriate methods and timing. Of particular interest may be surveys in the following:

- river corridor (conservation);
- botanical and other wildlife;
- aquatic biology;
- fisheries;
- landscape/amenity;
- recreation;
- hydrogeology;
- water quality;
- hydrology and drainage; and
- geomorphology.

The NRA will normally provide details as to what relevant information the Authority may hold.

## 7. Monitoring And Audit

Monitoring that is relevant to predicted impacts and mitigation measures is recommended and should not only make use of baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

## 8. General guidance

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF AIRPORTS

## 1. Introduction

This guidance note seeks to identify the potential impacts of airports upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) for the Environmental Assessment (EA) of airport schemes. The potential impacts of airports are of interest to the NRA because of the authority's responsibilities for flood defences, pollution control, water resources, fisheries, recreation and conservation management. Early consultation with the NRA will help to identify any environmental constraints and sensitive areas which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage. Consultation with the NRA will also be required as a licensing body for discharge and other consents.

Legislation requires that an EA is carried out for proposed airports and airport extensions. The responsibility for this assessment lies with the developer. It is advantageous to conduct the EA in advance of the design phase to enable proper consideration of alternatives. The EA's conclusions require proper justification and raw data should be accessible in the event of such a request.

## 2. Development control

Development control of airports is within the Town and Country Planning (T&CP) framework.

## 3. Environmental Assessment

Airports are listed under The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No 1199) under both Schedules 1 and 2. "Aerodromes with a basic runway length of 2,100m or more" are projects listed under Schedule 1, for which EA is mandatory. Smaller airport projects are classified as Schedule 2 projects for which EA is required when significant impacts are expected. Similarly, extensions to existing airports may require EA as a modification of a Schedule 1 project. Further guidance on the need for EA for such infrastructure projects may be found DoE Circular 15/88 (WO 23/88) and DoE/WO (1989).

## 4. NRA authorizations

Different licences or consents may be required with respect to the development, such as:

- **discharge consent** - for discharges to controlled waters (i.e. groundwaters, inland surface waters, and coastal waters);
- **abstraction licence** - for abstraction from groundwater or surface waters;
- **impounding licence** - for impounding of water;
- **land drainage consent** - for any works on the bed and banks of a river or construction of any structure likely to impede the flow.

Authorization from the NRA will also be required for the movement of fish (e.g. from ponds to be destroyed or to newly created ones) and for the use of herbicides in or near water.

## 5. Major/potential impacts upon the aquatic environment

The impacts of airport projects will occur in both construction and operation.

### 5.1 Construction impacts

The construction of airports will generally involve the clearance and levelling of the site for runways, car parks and buildings with the permanent loss of the habitats affected. Land take for level grassy areas, e.g. between runways, and subsequent management may result in altered habitats. Site drainage, including the diversion or culverting of existing watercourses will be of particular interest to the NRA.

**Site clearance** - The stripping of topsoil, levelling of ground surface and other excavation will result in the direct destruction of habitats and loss or displacement of associated organisms. Runoff from exposed and compacted soil may be rapid, leading to contamination of watercourses by high levels of suspended sediments, directly reducing water quality and indirectly reducing habitat quality through siltation. Siltation may be particularly significant where gravels in receiving streams are used by salmonid fish (salmon and trout) for spawning. Soil compaction and increased runoff from sites will also lead to increased flood risk downstream and decreased infiltration to groundwaters, the latter having implications for water resources and water table levels. Reductions in water table level will affect adjacent wetland sites. Compaction of soils and altered soil profiles may also determine subsequent flora and other associated wildlife.

**Disposal of spoil** - The disposal of spoil from levelling and excavation works, and also of topsoil set aside, will affect the ecology of the site of disposal. Spoil heaps may increase or reduce runoff and infiltration with corresponding impacts on surface or groundwaters. Runoff is likely to contain high sediment loads. In addition, exposure of both natural and contaminated soils to air and rain may produce a contaminated runoff from chemical processes and leaching.

**Demolition works** - Demolition works will result in the destruction of buildings and may cause damage to areas of cultural/archaeological interest. Associated habitats, e.g. bat roosts, will be lost. Debris from demolition works may enter watercourses causing pollution and increasing the risk of blockage and flooding.

**Dewatering** - Dewatering will have a direct effect on water table levels, with impacts on water resources and ecosystems dependent on water table levels, e.g. wetlands. Discharges from dewatering may potentially pollute receive waters, particularly if water is "drawn in" from contaminated land.

**Redirecting/culverting streams** - The redirecting of streams will result in the loss of established aquatic habitats and their ecological communities. In addition, changes to channel geomorphology arising from diversion may lead to further habitat changes beyond the area directly affected.

The culverting of channels will result in a loss of access to the river for both human (e.g. recreation) and wildlife use. The passage of migratory fish may be hampered where culverts discharge to rivers above the level of the water surface. Culverts may also present a flood risk should blockage occur from site and other debris.

Culverting, stream diversion and other channel or near-channel works may result in the disturbance of associated wildlife (e.g. feeding or breeding birds). Compaction of river banks by heavy machinery will lead to the loss in bank stability, and the destruction of soil structure and bankside flora. The disturbance of bank and river substrate may cause erosion and sediment resuspension leading to water quality deterioration. The loss of river substrate and disturbance to bed form (pools, riffles etc.) may represent a major loss of habitat. Damage from habitat loss and deterioration of water quality may lead to reduced species diversity (particularly of aquatic invertebrates and plants) and the loss of sensitive species. Angling quality may be affected by changes to access, fish populations, their food and habitat.

**General site activities** - General site activities may disturb wildlife and the outward migration of sensitive species. Vehicle movements may add to the erosion of soils and solid loads in runoff. Careless handling, storage and disposal of chemicals and fuel may result in pollution of groundwater and surface waters from spillages. Inadequate on-site sewerage, damage to existing sewerage or the disturbance of contaminated land may also cause pollution.

**Infrastructure** - The laying of cables, sewers, pipelines, roads and other associated infrastructure associated with the airport will also have impacts. The site may cause overloading of water supplies and wastewater treatment capacities. Other relevant guidance notes may be available from the NRA.

## 5.2 End state/Operational impacts

**Paved surfaces** - The extensive impermeable area presented by paved surfaces (runways, car parks) and buildings will result in greatly increased runoff from the airport, causing increased flow velocities, erosion and flood risk in receiving waters and decreased infiltration to groundwaters. Reduced groundwater levels may adversely affect water resources, wetland sites and river base flows. Changes to stream hydrology or flow regime are likely to affect aquatic life and recreation use of watercourses.

**Fuel/oil** - Spillages of fuel or oil in emergency or routine situations may cause surface water pollution with the loss of invertebrates, plants and fish etc. and may restrict downstream uses, including abstraction for public supply. Groundwaters may also be affected by such spillages. High pressure pipelines conveying fuel oil may represent a significant potential source of groundwater and surface water pollution.

**Other chemicals** - The use (or spillage) of chemical dispersant on oil/fuel spillages and extinguishants used in fire fighting may exacerbate pollution impacts. Similarly the use or spillage of de-icing agents (e.g. glycol, urea) and pesticides may cause pollution of surface and groundwaters, including deoxygenation. Surface water pollution from oil, fuel, chemicals and other substances may be a particular problem in runoff following dry weather or from snowmelt. Other potential sources of pollution are chemicals and other substances carried as freight, and those used in the maintenance and servicing of aircraft.

**Noise** - The movement of aircraft and other airport activity may disturb wildlife. In general, birdlife in the vicinity of the airport will be discouraged due to the risk of birdstrikes. Active measures to keep birds away may disturb bird and other wildlife.

Noise and vibration from aircraft take-off may affect buildings and other areas of archaeological/cultural interest. Also, recreational use of watercourses or water bodies may be disturbed by aircraft noise.

**Maintenance and support services** - Impacts, particularly pollution, may arise from maintenance and support services, such as inflight catering, aircraft services and freight handling. Impacts may arise from site sewerage; sewage from terminal buildings, associated businesses and aircraft may potentially overload the existing system and cause surface water pollution. The use of pesticides (particularly herbicides on runways, taxiways, roads and footways) may cause contamination of surface and ground waters.

## 6. Mitigation measures

Careful design of airports will minimize their environmental impacts. Alternative siting and designs should be considered, taking into account their environmental acceptability. Land-use mapping should be carried out at an early stage in the planning process, including the identification of sensitive sites such as:

- river flood plains;
- lakes, wetlands and marshes;
- rivers and river corridors of high ecological or amenity value;
- rivers supporting valuable fisheries;
- vulnerable aquifers as outlined in the NRA's *Policy and practice for the protection of groundwater* (NRA 1992);
- architectural, SSSI and other nature conservation sites.

This will enable re-designing or implementation of adequate mitigation measures to occur while the project is a desk study, avoiding costly alterations and/or delays at a later stage. Appropriate surveys carried out in the EA will enable the identification of habitats and/or species which will be affected by the development, thus enabling further avoidance or mitigation measures to be undertaken.

Mitigation measures will be case-specific but may include those described below.

**General construction** - Riparian zones should be avoided and appropriate construction materials used. Operations close to rivers should be properly engineered to avoid problems with the stability and long term performance of river banks and flood defences.

**Storage of fuel and equipment** - On-site equipment and materials should be carefully stored during construction and operation. Proper bunding should be provided for fuel tanks, away from water (preferably off-site) and locked when unattended. Bunds should be constructed such that all openings and fuel pipes are within the bund walls and that the bund itself has an adequate capacity. Drip trays should be placed under stationary machinery to collect oil and grease. The NRA will be able to advise on bund design.

**Drainage** - To reduce the risk of pollution of surface waters, a drainage system which collects the first flush of runoff (the first 10mm of rainfall) into a containment lagoon should be installed. The collected discharge should be carried to a sewage treatment works for treatment. A reservoir to hold the maximum possible contaminated flow from a major pollution incident should also be incorporated into the design. For example, the crash of a Boeing 747 could spill up to 180 000 litres of fuel and an equal amount of expanded foam could be applied, therefore the total capacity needs to exceed 360 000 litres. All discharge points should be fitted with an oil/water separator.

In addition, the installation of booms on major watercourses at risk from a major pollution from the airport will enable the spillage to be contained and recovered, thereby providing a high degree of protection.

Balancing ponds and artificial wetlands may provide a useful buffer/treatment system for routine drainage discharges. Lagoons may require surface aerators to counter deoxygenating effects of deicing agents in the water and algal blooms in the summer.

**Sewerage** - Sewage pumping stations may be required for the collection and distribution of sewage from the terminal building, related businesses or aircraft. The potential failure and overflow of such systems should be taken into account in sewerage/drainage design.

Drainage should also take into account pollution from maintenance and support services.

**Landscaping** - Careful landscaping of the site and its surrounds may reduce visual, noise and ecological impacts. Advance tree and shrub planting, if appropriate, will provide screening of construction works and may also act as a refuge for disturbed species.

**Noise** - Noise during construction should be minimized by careful selection of machinery and the use of baffles or screens. The timing and siting of operations should be chosen carefully to minimize disturbance to wildlife and recreational users. Timing of operations including aircraft flight times should be restricted.

**Access** - Alternative access should be made to watercourses for recreational use and maintenance if the present arrangements are affected by the development.

**Site restoration** - Non-paved areas affected by construction should be restored to a semi-natural state. To reduce damage to the physical properties of soils during site preparation and construction, it may be appropriate to carefully remove topsoil and subsoil and store it separately so that proper reinstatement can be carried out. If necessary, subsoil should be ripped prior to the spreading of topsoil. Mixing unlike soil materials should be avoided. Certain soil damage, e.g. compaction, may be reduced by restricting traffic movement and the use of protective boarding and low ground pressure machinery, especially during wet conditions. Sufficient care taken during the construction and reinstatement may minimize any long term residual effects on soils drainage or vegetation. Excavated soil should be carefully disposed of, possibly off-site.

**Habitats** - Loss of habitats can be minimized by restricting the working width during construction of runways, roads, cable laying operations etc. Reinstatement of affected habitats should be undertaken wherever possible, although for some (e.g. wetlands) this may be complex and specific consultation with the NRA is recommended so that the best available and practical methods are employed. Where a habitat will inevitably be destroyed by the development, habitat/species rescue and habitat creation should be undertaken, e.g. the creation of new and restoration existing ponds and wetlands, through the translocation of soils, sediments, fauna and flora.

**River diversions** - Material should be translated from the existing to the newly created river channels in instances of river diversions. In such instances, remnants of the old channels should be retained as wetlands, ponds or blind-ending channels.

**Culverts** - Where unavoidable, culverts should be designed so as not to disrupt fish movement, and should have adequate clearance to allow the passage of both wildlife and debris. The incorporation of trash screens may be useful to prevent the build-up of debris in inaccessible areas, but these should be regularly maintained (with maintenance agreements made in advance of installation). Culverts should be designed to take highest predicted flows.

**Pesticides and fertilizers** - The use of pesticides and fertilizers should be minimized and used in accordance with the relevant guidelines, such as MAFF (1985) and NRA (1995). Watercourses should generally be avoided; approval from the NRA will be required for the use of herbicides in or near watercourses. Buffer areas (areas of land around watercourses, unaffected directly by the applications) may be used to intercept runoff and reduce the amounts of these chemicals entering watercourses. The use of herbicides should be minimal in the vicinity of important aquifers.

## 7. Baseline surveys

Field surveys should be appropriate with respect to timing, timescale and methods used and preferably include surveys conducted at a similar time of the year to the proposed construction, in the year (or years) prior to the works.

Field surveys should be sufficient to:

- establish the pre-construction (baseline) state of the site;
- allow the determination of critical environmental factors upon which to give rapid on site advice during construction;
- determine the best operational conditions for the aquatic environment during construction such as water level in wetlands, water flow in rivers and allowable sediment load or deoxygenation effects on river biota including fish;
- optimize the reinstatement of channels or wetland areas by the appropriate choice or extent of use of a specific technique; and
- identify construction practices with a high environmental risk, economic liability or publicity factor

The surveys required are site specific but is likely to include:

- river corridor surveys;

- aquatic, riparian and wetland ecology;
- water quality;
- water resources;
- hydrology;
- hydrogeology;
- landscape/amenity;
- recreational use;
- archaeology; and
- river geomorphology.

## 8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended and should not only make use of the baseline surveys but also consider further pre-scheme surveys. Post-scheme monitoring data should be regularly reviewed. The review or audit should also include compliance with agreed management practices.

## 9. References and guidance

Department of the Environment/Welsh Office (1989) *Environmental Assessment - A guide to procedures*. HMSO.

Harris, R. C. (1993) Groundwater pollution risks from underground storage tanks. *Land Contamination & Reclamation*, 1 No. 4, 197-200.

Maeda, M. (1991) The Kansai International Airport Project and Environmental Impact Assessment. *Marine Pollution Bulletin*, **23**, 349-353.

Ministry of Agriculture, Fisheries and Food (1985) *Guidelines for the Use of Herbicides on Weeds in or near Watercourses and Lakes*. MAFF. (NB these guidelines are currently being updated).

National Rivers Authority (1992) *Policy and practice for the protection of groundwater*. HMSO, London.

National Rivers Authority (1994) *Guidance notes for Local Planning Authorities on the methods of protecting the water environment through development plans*. NRA, Bristol.

National Rivers Authority (1995) *The use of herbicides in or near water*. NRA (Anglian Region), Peterborough.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CEMETERIES

## 1. Introduction

This guidance note seeks to identify the potential impacts of cemeteries upon the water environment. It is intended to act as a fairly detailed general scoping brief to convey the concerns of the National Rivers Authority (NRA) with respect to the environmental impacts of cemeteries. The potential impacts of cemeteries are of interest to the NRA because of the authority's responsibilities for pollution control, fisheries, recreation and conservation management. Early consultation with the NRA will help to identify any environmental constraints and sensitive areas which may be avoided, thus obviating the need for redesigning and mitigating avoidable impacts at a later stage.

Although planning legislation does not require a formal Environmental Assessment (EA) to be carried out in connection with proposed cemeteries, environmental studies of some form will usually be required by consultees, such as the NRA, who are commenting on the proposals. The responsibility for such studies, which may take the form of an EA, lies with the developer. It is advantageous to both contact the NRA and conduct the studies or EA in advance of detailed designs to enable the identification of environmental constraints and the proper consideration of alternatives.

## 2. Development control

Cemeteries are covered by the Town and Country Planning framework. Under the recently consolidated General Development Order the NRA are statutory consultees for development relating to the use of land as a cemetery.

## 3. NRA licences

Under the Water Resources Act 1991 the NRA is the licensing body for abstraction and impounding licences and discharge and land drainage consents. Of these the most applicable would be land drainage consents, required for any works on the bed and banks of a river or construction of any structure likely to impede the flow. Such a consent must be obtained in advance of any construction, regardless of whether planning permission has been granted.

## 4. Potential impacts upon the aquatic environment

The main impact of cemeteries is groundwater contamination from corporeal decomposition products. This and other generally less significant impacts caused during both the construction and operation of cemeteries are discussed below.

### 4.1 Construction impacts

**Preparation of the working area for new roads, chapels, toilets** - This may result in damage to the site flora from land take, direct damage and through compaction and other physical disruption of the soil. In addition, the temporary disposal of excavated soil may extend the area affected. There may be a loss of bank stability from bankside operations. Fauna may be affected that are dependent on trees and other vegetation, e.g. birds and bats may utilize trees as nesting or roosting sites.

Increased runoff resulting from soil compaction and vegetation losses and may result in increased river flows and therefore flood risk. In addition, groundwater resources may be affected by reduced infiltration of precipitation. Runoff and soil disturbance may lead to soil erosion with subsequent pollution from raised levels of suspended solids, decreasing water quality. Pollution by suspended material may have a direct effect on sensitive aquatic life from abrasion or from the attenuation of light in turbid water. In addition, sedimentation in rivers may affect substrate characteristics for aquatic flora and fauna, and reduce the quality of gravels for fish spawning, particularly trout and salmon. Reduced fish stocks will affect angling opportunities for such stocks. Angling and recreation may also be impaired by construction activities, e.g. at river banksides and crossings.

Archaeological interests may be unearthed or damaged by excavations.

**Machinery and Vehicles** - The general operation of machinery and vehicles may contribute to problems of soil compaction and soil stability. Leaking or spilled fuel and oil from stores, vehicles or machinery may contaminate both groundwater and surface waters.

### 5.2 End state/Operational impacts

**Contamination of ground/surface water from decomposing bodies** - Leachate from decomposing bodies may enter groundwater or surface water causing a deterioration in quality and potential health risks from microbial contamination. Deterioration of water quality from leachate with a high biological oxygen demand may result in the loss of fish and other aquatic life. The amenity value of watercourses may also be decreased by odour and other aesthetic problems. Polluted groundwater and surface waters may affect other users and water resources. Leachate may be more problematic in poorly drained sites with a high water table.

**Fertilizer and pesticide application** - Fertilizers and pesticides applied to cemetery in site maintenance may be carried into site runoff (particularly if rainfall occurs soon after application) and drainage. Chemical contamination of both groundwater and surface water may occur. Biological communities could be affected with a loss of sensitive species (both plants and animals).

**Grave digging** - Mechanical or manual excavation of graves may result in damage to the site flora from direct damage and through compaction and other physical disruption of the soil. Increased erosion from the disturbed soils may lead to pollution from raised levels of suspended solids, decreasing receiving water quality.

**Graveyard mowing/strimming** - Spills of oil and/or fuel from lawnmowers, strimmers or excavators may enter the groundwater or surface water causing a decrease in water quality; having a negative impact on the fauna, flora and amenity value of watercourses. The noise of mowers, strimmers and excavators may disturb wildlife and recreational users.

## 6. Mitigation measures

In general, cemeteries proposals should avoid sensitive areas such as:

- vulnerable aquifers;
- rivers, river corridors and other areas of high ecological or amenity value;
- river floodplains;
- lakes, wetlands and marshes;
- rivers supporting valuable fisheries;
- contaminated land likely to lead to polluting runoff if disturbed (without remediation); and
- upland areas of catchments with particular sensitivities.

Careful siting, design and operation should minimize the environmental impacts of cemeteries.

**Site drainage** - Where groundwater or surface waters may be at risk there should be an adequate drainage system to collect site drainage, including leachate, for appropriate treatment, e.g. by connection to a sewage treatment works.

**Buffer areas** - Strips of undeveloped land around watercourses may be used to intercept runoff and reduce the amounts of sediment and nutrients entering such watercourses.

**On-site activity** - If possible, maintenance activity should avoid sensitive locations or times of the year. Noise may be minimized by careful selection of machinery. Mowing regimes for border areas may be adopted to enhance conservation value.

**On-site equipment** - including fuel and oil, should be should be stored carefully in secure dry conditions, possibly off-site. Stores containing significant volumes of fuel or chemicals should be bunded to contain the liquids in the event of vandalism or spillage.

**Drip trays** - should be placed under stationary machinery to collect oil and grease.

**Pesticides and fertilizers** - should be used in accordance with the relevant guidelines (e.g. MAFF (1985), NRA (1995)) and avoid watercourses, buffer strips and other semi-natural areas. The NRA must be notified of there intended use near watercourses.

## 7. Baseline surveys

Surveys should be appropriate with respect to timing, timescale and methods used. The surveys programme should preferably include those at the same time of the season as the proposed construction, in the year prior to the works.

Relevant surveys may include:

- hydrogeology;
- groundwater and surface water quality;
- river corridor/ecological surveys;
- aquatic biology;

- fisheries;
- recreational and other use; and
- archaeology.

## 8. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures should be considered.

## 9. General guidance and references

Ministry of Agriculture, Fisheries and Food (1985) Guidelines for the use of herbicides on weeds in or near watercourses and lakes. MAFF. (NB these guidelines are currently being updated).

NRA (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

Pacheco, A., Mendes, I., Martins, T., Hassuda, S. and Kimmelmann, A. (1991) Cemeteries - a potential risk to groundwater. *Water Science and Technology*, **24** No. 11, 97-104.

Van der Honing, H., Brinkmann, F.J.J. van der Ende, P.J. and Hooimeijer, A. (1988) The quality of surface water, drainage water and groundwater in the neighbourhood of cemeteries. *$H_2O$*, **21** No. 12, 327-331. (In Dutch, English summary p319).

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF NAVIGATION ISSUES

## 1. Introduction

This guidance note seeks to identify the potential impacts of issues relating to navigation upon the water environment. It is intended to form the basis for a scoping brief to cover the concerns of the National Rivers Authority (NRA). The potential impacts of navigation issues are of interest to the NRA because of the authority's responsibilities for navigation, water quality, water resources, fisheries and conservation.

In general, small-scale navigation issues as discussed in this note will not require formal Environmental Assessment (EA) under the relevant regulations. However, the principles of EA may apply to ascertain the impacts of navigation issues as described. Larger scale development such as marinas are described in separate guidance.

## 2. Development control

Some relevant issues with respect to navigation may be subject to planning controls under the Town and Country Planning framework. In general, the NRA should be contacted with respect to navigation developments. Under the recently consolidated General Development Order, the NRA are statutory consultees for development involving the carrying out of works or operations in the bed of or on the banks of a river or stream.

## 3. NRA authorizations

The NRA are the competent navigation authority on certain rivers (e.g. Thames, Medway, Dee Estuary) and as such may issue boat and other relevant licences and introduce various byelaws etc. A **navigation consent** or licence will be required to undertake works in, on or over a navigable river where the NRA is the navigation authority.

## 4. Major potential impacts upon the aquatic environment

### 4.1 Construction issues

Construction impacts that may arise include those from the installation or modification of locks, moorings, slips, pilings etc. The impacts of even small developments are potentially very significant due to the essential proximity of watercourses or water bodies.

**Preparation of the working area** - This may result in damage to the site fauna and flora from direct damage and physical disruption of bankside soils and riverine sediments. Excavation may unearth and damage sites of archaeological interest. The temporary disposal of excavated materials may extend the affected area. Bankside operations may also cause bank instability.

Fauna may be affected by habitat loss both within the water channel and on the bankside, e.g. bankside trees and vegetation may be used by birds and bats as nesting or roosting sites. In addition, bankside trees may be used by otters and also provide shade; tree loss may result in raised water temperatures, and problematic plant and algal growth.

**Construction** - The construction of within water structures works will inevitably lead to disturbance of sediments and increased suspended solids. Further suspended solids may enter the river as runoff from disturbed bankside soils. This deterioration in water quality may affect organisms which are sensitive to abrasion or the attenuation of light from turbidity. Substrate characteristics may also be affected and this could result in changes in aquatic ecology, organisms favouring a more silty sediment becoming more dominant. Siltation may seriously affect gravels used for spawning by salmon and trout, with reduced egg-to-fry survival. Reduced fish stocks or a shift in species will affect angling quality.

Major works on locks may necessitate temporary cessation of use, for both boat and other users (e.g. pedestrian river crossings).

River works may result in an altered channel morphology with respect to channel width, depth, shape, gradient and bedform (riffles, pools etc.) and will lead to the deposition of suspended solids upstream with an associated loss of sediments deposited downstream. Changes in the riverine environment will have an impact on the aquatic fauna and flora.

Within or near river works may also disrupt access to the river, navigation, angling and other water-based activities. The installation of rigid concrete and metal bankside structures will prevent use of the bank as habitat. e.g. for voles, kingfishers etc., and access points for wildlife may also be affected. There will also be an aesthetic loss of "naturalness".

## 4.2 Operational issues

There is a variety of operational issues that may have environmental implications, ranging from boat movements on the waterway to dredging to maintain its use for navigation.

**Boat movement** - Waves and so-called "boat-wash" may cause erosion of the banks and/or riverbed and result in high levels of solids maintained in suspension. Erosion and boat-wash may damage bankside habitats and wildlife, and increase channel width. Waves and boat-wash may disturb nesting birds and damage nests. Increased sediment loads may lead to increased turbidity and sedimentation downstream. Boat-wash and movements may disturb anglers and other users, resulting in conflicts between user groups. Moored boats may block access to the river for anglers and other users.

**Pollution** - Pollution may be caused by the resuspension of contaminated sediments or directly from the boats themselves through the release of oil/fuel, chemical or organic materials to the waterway. Rubbish may also be released from boats either accidentally or carelessly.

**Flow regulation** - The use of locks generally improves access to the river for boats and can also be used to prevent flooding defence. Locks and weirs may also provide pedestrian crossing points and amenity areas. Altered flows through flow regulation and from locks may alter aquatic communities and affect recreational activities, such as angling. Stagnation of flow in the lock cut at time of low usage may result in deterioration of water quality thereby affecting aquatic life and decreasing the resource value for other users.

**Water releases** - Releases or artificial freshets may be made on rivers for canoeing purposes, improving the recreational value with respect to this pursuit. However, the increased water velocities may cause erosion of the bed and banks, high levels of suspended solids, washout of aquatic life, and a localized rise in the water table (if sustained). Alternation between high and low flows may have major impacts on the aquatic invertebrate and plant communities with species adapted to low flow, silty conditions not tolerating the high flow conditions and *vice versa*. The fish community, its distribution, behaviour, migration and spawning may be affected both directly and indirectly by freshets. Angling and other recreational use may be affected by flow changes (and fish distribution).

**Dredging** - From time to time navigation channels may need to be dredged, resulting in a myriad of impacts. Navigation may be disrupted whilst the dredging operations are underway. Dredging operations will increase the suspended solids loading through the remobilization of sediments back into the water column. A variety of contaminants including oil, pesticides, and other chemicals, may be associated with the sediment particles. Thus, the net effect may be a reduction in water quality and which may seriously impact on aquatic fauna and flora and other water use, e.g. abstraction. Bankside users will also be affected as access to the banks may be limited by the temporary deposition of dredged materials along the river edges. The material will have a physical impact on underlying soils and associated flora and fauna, and may have amenity impacts from its appearance, odour and attracted flies. Dredged sediments may also pollute soils and water from leaching and runoff of associated contaminants.

## 5. Mitigation measures

**Bankside construction** - Sensitive and important habitats should be avoided and protected, where possible. General disturbance to wildlife, plants and habitats can be reduced by restricting the width of operations and the appropriate phasing of construction work to avoid sensitive times, e.g. sensitive times for bird populations include the breeding season, roosting and migratory concentrations. Similarly, disturbance to recreation caused by construction works can be minimized by timing operations carefully. For example, construction work on locks should be executed outside of the main boating season. Where possible alternative access and crossing arrangements should be made. The duration of construction and other works should be minimized.

**Boat movements** - The imposition of mandatory speed limits on vessels will reduce wave action and the impacts of boat-wash on bank and bed sediments and the aquatic communities. Mooring areas should avoid key angling pegs and other recreational access points.

**Flow regulation** - Freshets for canoeing should be carefully planned with respect to duration and flow. Advance notification of freshets to other user groups may reduce impacts on members of such groups. Stagnation within locks may be prevented by periodic or continuous (trickle) flushing.

**Dredging** - Dredged material should be disposed with consideration of the sensitivity of receiving site and the level of sediment contamination in mind. Disposal to landfill may be required for particularly contaminated material.

Disturbance to recreational users from dredging activities may be minimized by timing operations carefully.

## 6. Baseline surveys

Surveys may be required to ascertain the value and sensitivity of sites to navigation developments. Surveys should be appropriate with respect to timing, timescale and methods used.

The surveys required are case-specific but are likely to include:

- water quality;
- aquatic ecology, e.g. river corridor surveys;
- fisheries;
- recreational use;
- archaeology;
- geomorphology; and
- hydrology;

## 7. Monitoring and audit

Monitoring that is relevant to the predicted impacts and mitigation measures is recommended. Monitoring data should be regularly reviewed, such that action may be taken to resolve issues arising.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF NAVIGATION WORKS

## 1. Introduction

This guidance note seeks to identify the potential impacts upon the water environment arising from navigation works. It is intended to form the basis of a scoping brief to identify issues arising from navigation works likely to be of concern to the NRA. It should assist external developers and navigation authorities to identify potential impacts on the water environment that may result from navigation works. Mitigation measures that can be used to avoid these impacts are also suggested.

The NRA has an interest in navigation works due to its statutory responsibilities as a navigation authority and also those under the 1991 Water Resources Act (WRA) for the protection of the water environment and for flood defence purposes. In addition, the WRA lays down a general duty for the NRA to promote the recreational use of inland and coastal waters and associated land.

The NRA is the navigation authority for approximately 800 km of river navigation on certain rivers including the Thames, Medway, Nene, Great Ouse System and others. As a navigation authority the NRA's principal aim is to improve and maintain inland waters and their facilities for use by the public (NRA, 1993a). In order to achieve this aim, the NRA undertakes programmes of repair, maintenance and improvement of navigable waterways, including the provision of new facilities. The NRA also has permissive powers which can be used to regulate navigation on inland waters over which there is a public right of navigation but where there may not be a navigation authority. Liaison and collaboration is maintained with the other two main inland navigation authorities, British Waterways and the Broads Authority.

This guidance note describes the potential impacts on the water environment of navigation developments such as bankside mooring, maintenance facilities and jetties. It does not examine the impact of dredging, vegetation management or marina developments as these are dealt with in other guidance notes, specifically:

- Guidance Note 3. (Marinas)
- Guidance Note 31. (Channel Works; including fluvial dredging)
- Guidance Note 40. (Suction Dredging)
- Guidance Note 45. (Vegetation Management)

## 2. Development control

Development involving the construction of new moorings, jetties or similar navigation facilities by a developer other than a navigation authority will require local planning authority consent under the Town and Country Planning system. The NRA is a statutory consultee for such developments as they will involve works or operations in the bed of, or on the banks of a river or stream.

## 3. Environmental Assessment

No developments likely to be associated with the navigation works are identified in the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) as requiring Environmental Assessment (EA). Works undertaken by navigation authorities are exempt from these Regulations.

Although a formal EA of a development including navigation works such as mooring facilities may not be required by a local planning authority, it is nevertheless good practice for a developer to undertake an assessment. The NRA, as consenting authority for navigation and also for land drainage (see next section), may request that environmental information be made available in order to determine such consent. Some form of EA may provide the most appropriate means by which a developer can collate relevant information. This could follow the overall guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

Under Section 109 of the WRA, consent is required from the NRA for the erection of any structure in, over or under a watercourse which is part of a main river. This includes developments such as bankside mooring facilities and jetties.

On 'ordinary' watercourses, NRA consent is likely to be required under Section 23 of the Land Drainage Act 1991 for the erection of any structure that may affect its flow. Navigation, Harbour and Conservancy Authorities are exempted from this Section, although not from obtaining consent under Section 109 of the WRA.

A navigation consent or licence will be required for any proposed works in, on or over a navigable river where the NRA is the navigation authority.

## 5. Major potential impacts

Structures used in navigation, such as moorings and jetties, involve construction both in and adjacent to water. The impacts on the water environment of general construction activities are described in Guidance Note 1. of this series (General Construction). This guidance note (No.28) refers to some specific construction impacts of navigation facilities but is primarily concerned with the potential end-state impact of such developments.

Navigation works can provide beneficial impacts to water-based commerce, boating and recreational users of the water environment. They may also provide social and economic benefits to a local community which may be particularly important in rural areas. In general, such impacts will be implicit in the rationale for any particular development and are therefore not examined in detail here. Such positive impacts must nevertheless be identified and evaluated in an EA of navigation works.

## 5.1 Geomorphology

Machinery used in construction on land can cause compaction of topsoil which may interfere with land drainage. Excavation of foundation trenches and subsequent disposal of soil may result in washing of loose material into nearby water, causing an increase in turbidity and deposition of sediments.

The excavation of any part of a river bed is likely to cause suspension of sediments with downstream deposition during the course of works. In some watercourses it is possible that contaminated sediments trapped in the river bed will be re-suspended. Excavations may alter natural channel morphology and the erection of any structure could result in the loss of morphological variability. A fall in bed level due to excavation within a development site may cause channel adjustment up and downstream, loss of pool-riffle sequence and bank instability.

## 5.2 Hydrology

Where moorings, jetties or slipways project into a river channel they may impede water flow and create an increased risk of flooding (NRA, 1994a). Mooring of craft at such facilities is likely to impede river flow still further. The potential impact of mooring facilities on flooding regimes will depend on whether the facilities are intended for overnight stays or permanent mooring. Moorings, jetties or slipways and the consequent presence of craft may also impede river channel maintenance operations.

New structures on land associated with navigation facilities may obstruct the flood storage capacity of a floodplain and impede the lateral and downward flow of water within this area. Similarly, spoil from excavations or landscaping around a navigation development that involves raising ground level may also present a threat to flood storage capacity.

## 5.3 Water quality

A short-term reduction in water quality is likely during construction of moorings or jetties due to an increased water turbidity and sediment load from excavations.

Water pollution may arise directly from navigation facilities designed for boat mooring, fuelling or maintenance by leakage of chemicals or an accident within the development. Navigation activity associated with such developments may also contaminate the water environment through the release of oil, fuel or chemicals, particularly from outboard motors and submerged exhaust emissions.

Where new navigation facilities allow boats to moor on a riverside, sewage effluent could enter surface waters. The high organic content of such effluent can cause localised eutrophication of water, with strong growth of algae and "sewage fungus". The resulting high biochemical oxygen demand can result in local de-oxygenation of a watercourse. It is probable that such contamination would be detrimental to water colour and result in an offensive odour. Effluent associated with navigation facilities may also contain detergent or other harmful chemicals that will adversely affect water quality. These detrimental impacts on water quality would be of particular concern as any navigation development is likely to be situated within an area where water-based recreation activity is common.

## 5.4 Aquatic ecology

The construction of any structure in water, such as mooring facilities, access ramps, or jetties will inevitably result in direct destruction of marginal and aquatic habitats and species. Material suspended by excavations may damage fish through abrasion of the gills and reduce photosynthesis of rooted plants or algae by attenuation of sunlight, although these will be short-term impacts. Deposition of sediment away from a construction site may smother benthic organisms and cause change in an aquatic community where organisms adapted to a depositing environment are favoured.

In the longer term, change in the substrata of a river bed, by for example dredging may result in a reduction of ecological diversity and loss of fish spawning gravels and/or plant cover. The potential loss of natural marginal habitats such as riverbanks or wetlands, due to erection of navigation structures, would also reduce ecological diversity within the river corridor.

The development of navigation facilities offers an opportunity for habitat creation and/or enhancement in and adjacent to the water environment. Beneficial impacts for aquatic ecology that arise directly as a result of a development scheme should be described and evaluated in an EA.

## 5.5 Terrestrial ecology

The creation of navigation facilities may cause direct destruction of terrestrial and riparian habitats and flora. This may include the loss of mature trees and other vegetation that act as breeding or feeding sites for wildlife, including birds, and provide shade to the margins of a water body. In turn this may result in the disturbance or loss of insects mammals and birds. It is possible that new man-made structures adjacent to, or in, surface waters could disrupt the movement of small mammals.

As is the case for the aquatic environment, a new development may create new terrestrial habitats or be able to enhance or protect existing ones.

## 5.6 Landscape

The construction of navigation facilities is likely to require land-take directly adjacent to a water body. This may include agricultural land, natural habitat or sites of environmental or archaeological interest. The land-take may be temporary for the duration of works, or permanent.

The visual impact to the landscape of any navigation facilities will depend on its siting, purpose and design. The creation of any man-made structure in or at the margins of the water environment may be intrusive and cause an adverse visual impact, particularly where the site is within an area of high aesthetic value. Nevertheless, where project siting and design are sensitive to the existing environment and appropriate mitigation measures are used to minimise operational impacts, the overall visual effect can be beneficial to the water environment. This is particularly likely to be the case where a navigation development is situated in an urban or semi-urban setting. A visual impact assessment should be undertaken as part of an EA of any moderate to large navigation works.

### 5.7 Human beings

Construction of navigation facilities may cause temporary disturbance and disruption to local residents, businesses and users of the area. This may be due to noise or dust emanating from a development site, or by closure of roads or footpaths while construction work is undertaken. The works may result in a temporary loss of amenity for water users and existing boat moorings or other facilities may be made inaccessible for a time.

New navigation facilities may permanently disrupt pedestrian access to water, angling and other water-based activities in the vicinity of a site. However, they are also likely to provide considerable navigation, recreation and amenity benefits to some users of the water environment. An EA should examine the human impact of navigation facilities in relation to all water users. Mitigation measures can then be introduced at the project design stage to avoid or minimise conflicts of interest or losses likely to be incurred by any user group.

## 6. Mitigation measures

A fundamental aim of using EA procedures as an integral part of the design process is to ensure that potentially damaging effects are avoided or minimised and that the beneficial aspects of a development or activity are enhanced. Possible mitigation measures are presented here for the construction activities and end-state of navigation facilities.

### 6.1 Construction

- On site supervision of working practices should follow the appropriate NRA guidelines (NRA, 1994b, 1994c).
- Sensitive periods, such as the fish spawning and bird breeding seasons should be avoided.
- Sensitive terrestrial habitats and trees should be avoided during construction work.
- Excavation and dredging should be minimised wherever possible.
- Excavation work should be undertaken at periods of normal or lower flow to minimise silt disturbance.
- Downstream siltation should be reduced by construction of a temporary silt and sediment trap.
- All surplus excavated material should be removed from the floodplain.

### 6.2 End-state

- New moderate or large sized navigation developments should be situated, if possible, in riparian or shoreline areas of low conservation and landscape interest. Derelict land or land of low amenity value might be used.
- Navigation developments should be sited in areas which minimise conflict with other users of the water environment.
- Consideration should be given to the maintenance or improvement of riverside access in the design of any navigation works.
- New navigation facilities should be designed sympathetically to blend into the surrounding environment. The use of natural materials and non-uniform shapes may help reduce intrusive visual impact, as can planting of trees or other vegetation.
- Aquatic and/or riparian habitat creation or enhancement should be incorporated into navigation developments wherever possible. This could involve, for example, the formation of marginal shelves or wetland areas and tree planting along a riverbank. The *New Rivers and Wildlife Handbook* (RSPB *et al*, 1994) provides many examples of project design to benefit wildlife.
- Navigation works associated with mooring, fuelling or maintenance of craft should be designed and operated in accordance with NRA Pollution Prevention Guidelines (NRA, 1994d). The use of water craft at navigation facilities should also follow these guidelines.
- All boat service areas should have an oil separator installed on the surface water drainage system. This should be regularly inspected and cleaned as required. A Guidance note on oil separators is available (NRA, 1994e).
- Adequate provision should be made for oil and fuel storage where this will occur. An impervious base should be created within an oil-tight bund for oil/fuel tanks and drums. There should be no drainage outlet. Guidance notes on the storage and disposal of oil and fuel are available from the Authority (NRA, 1994f, g).
- Land-based sewage disposal facilities should be provided at any long-term (greater than 48hr) boat mooring.
- Moorings should be parallel to the river flow and should be constructed so as not to present a maintenance problem.
- Where possible, new moorings should be let into the banks of a watercourse to reduce obstruction to flow.
- Double berthing should not be introduced where this will result in a significant obstruction of the waterway.
- Embankments and fences associated with navigation developments should not obstruct floodplain flows.

## 7. Baseline surveys

Hydrological data will be required for an EA of navigation facilities such as moorings, slipways etc. to aid assessment of the implications of development on the floodplain. Localised geomorphological survey should be used to assess impacts on channel morphology. Ecological surveys of aquatic, marginal and terrestrial habitats adjacent to the development site should be conducted; this could take the form of a river corridor survey (NRA, 1992).

A visual impact assessment or river landscape assessment would be appropriate for EA of large facilities (NRA 1993b).

## 8. Monitoring

An appropriate monitoring strategy should be developed to confirm the predicted environmental impacts of any navigation facilities. Local changes in river morphology and sediment distribution should be recorded for several years after completion of the project. The effectiveness of mitigation measures should also be assessed and the recovery of terrestrial, riparian and aquatic habitats and establishment of new vegetation or habitats evaluated.

## 9. References and guidance

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

National Rivers Authority (1992) *River Corridor Surveys: Methods and Procedures.* Conservation Technical Handbook No. 1, NRA, Bristol.

National Rivers Authority (1993a) *NRA Navigation Strategy.* NRA, Bristol.

National Rivers Authority (1993b) *River Landscape Assessment: Methods and Procedures.* Conservation Technical Handbook No. 2, NRA, Bristol.

National Rivers Authority (1994a) *Flood Defence Technical Liaison Manual: Guidelines for Land Drainage Consenting & Planning Liaison.* NRA, Severn-Trent Region.

National Rivers Authority (1994b) *General Guide to the Prevention of Pollution of Controlled Waters.* Pollution Prevention Guidelines No. 1, NRA, Bristol.

National Rivers Authority (1994c) *Works in, near or liable to affect watercourses.* Pollution Prevention Guidelines No. 5, NRA, Bristol.

National Rivers Authority (1994d) *Inland Waterways: Marinas and Craft.* Pollution Prevention Guidelines No. 14, NRA, Bristol.

National Rivers Authority (1994e) *The Use and Design of Oil Separators in Surface Water Drainage Systems.* Pollution Prevention Guidelines No. 3, NRA, Bristol.

National Rivers Authority (1994f) *Above Ground Oil Storage Tanks.* Pollution Prevention Guidelines No. 2, NRA, Bristol.

National Rivers Authority (1994g) *Safe Storage and Disposal of Used Oils.* Pollution Prevention Guidelines No. 8, NRA, Bristol.

Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CHANNEL WORKS

See Guidance Note 31

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FLOOD DIVERSION CHANNELS

## 1. Introduction

This guidance note seeks to identify the potential environmental impacts of flood diversion channels. It is intended to act as a general scoping brief for environmental impact studies of such developments. It should assist any drainage authority intending to construct a flood diversion channel to identify the potential impacts that may be associated with such a project. Mitigation measures to avoid or reduce such impacts are suggested.

The National Rivers Authority (NRA) has a statutory responsibility for flood defence under the Water Resources Act 1991. In order to fulfil this obligation the NRA undertakes a wide variety of developments designed to protect people and property from flooding where this can be achieved in a cost effective and environmentally sensitive manner. Inland, such projects include flood embankments, flood storage areas and flood diversion channels. Such projects may also be undertaken by other drainage authorities.

A flood diversion channel may also be called a flood relief channel or a bypass channel. This type of development involves the construction of a new channel to accept water during times of high flow and minimise the risk of flooding to adjacent land. This type of flood defence represents a possible alternative to deepening or widening an existing river channel. It may be seen as a valid option when the opportunity for channel widening is restricted by development, where valuable habitats would be at risk from channel enlargement or where other engineering proposals, conflict with the existing alignment.

## 2. Development control

New flood defence works, such as the construction of a flood diversion channel are subject to planning control and a proposal for such development therefore requires consent from a local planning authority.

## 3. Environmental Assessment

A flood diversion channel may require an Environmental Assessment (EA) under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1199). This decision rests with the local planning authority and is based upon the likelihood of significant environmental impacts resulting from the development.

The Land Drainage Improvement Works (Assessment of Environmental Effects) (Amendment) Regulations 1995 (SI Nº 2195) places an obligation on any drainage authority proposing to carry out certain drainage works to undertake a prescribed procedure. The drainage authority must consider whether, by reason of its nature, size or location, the proposed project is likely to have significant effects on the environment and ought therefore to be made the subject of an environmental statement. It is for the drainage authority to determine if an EA is warranted. The Regulations describe whether or not an EA is to be carried out and indicate measures that must be taken to publicise the proposed project.

Notwithstanding these regulatory requirements, the Water Resources Act 1991 assigns the NRA with a duty to assess the impacts of all its activities on the environment. An EA of some form will therefore be necessary for all flood diversion channel projects. Projects that are judged by an initial EA not to have significant impacts may be reported as such in a Written Justification that can accompany the planning application. Where significant environmental impacts are identified in initial studies, a full EA, reported in an Environmental Statement may be required.

It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement, whether required by Regulations or not, follow the guidelines published by the Department of the Environment (DoE, 1995).

## 4. NRA consents

As the NRA is responsible for the planning and operational aspects of flood defence works and is also the authorising body for land drainage consents for works on or alongside designated main rivers. The question of NRA consent will be an internal matter when the Authority takes the role of developer. If another drainage authority, such as an internal drainage board or local authority, is the developer, then consents under either Section 109 of the Water Resources Act 1991 (Main River) or Section 23 of the Land Drainage Act 1991 (Non-Main River) may be required.

## 5. Major potential impacts

A flood diversion channel may take one of several forms and its specific physical characteristics are likely to be determined by local geological and hydrological criteria. A proposed development may involve the creation of a dry channel, or one that allows for a given level of water flow under normal flow conditions. A channel may take a simple cross-sectional shape or be designed as a two-stage or multi-stage channel that allows a minimal flow to cover the river bed of the lowest stage while retaining a large floodwater retention capacity in the upper section. A channel may follow a simple line or curve, or may undergo a complex sinuous meander.

Many of the potential impacts of any scheme are likely to be specific to a particular site and an EA should examine local conditions. Consultation with local community groups prior to project design is recommended, in addition to any statutory requirements in this respect.

As a formal EA may be required for a flood diversion channel, it is necessary to consider the potential impact of a project upon all environmental components. Major potential impacts are presented here for both the construction phase and end-state of the development.

### 5.1 Construction

Whatever form of design is adopted for a flood diversion channel the main elements of any construction will be broadly similar. These are the requisition of land and excavation of a new river channel. Significant potential impacts arising from these activities may be:

- loss of agricultural land;

- loss of natural terrestrial habitat, such as woodland, grassland or hedgerows;
- disturbance or loss of terrestrial fauna and flora, which may include rare or protected species;
- loss of individual trees - this may be particularly important in an urban or semi-urban environment;
- disturbance or destruction of archaeological sites, or other sites of local interest;
- noise disturbance to local residents and property by movement of plant and other vehicles;
- creation of dust which may be blown to local residences, or mud that may be spread to local roads by development traffic;
- compaction of soil by heavy vehicles along access routes and within the development site;
- disruption to local traffic and pedestrians in the area of the development site;
- disturbance of contaminated land by excavation activities - this may result in secondary impacts due to seepage that may affect surface or groundwater quality;
- disposal of excavated material, whether on-site or elsewhere, may cause destruction of terrestrial habitat and visual intrusion;
- where flood diversion channel works impinge on an existing river channel, this may increase suspended sediments and water turbidity, with an associated increase in sediment deposition downstream for the duration of construction.

## 5.2 End state

The construction of a flood diversion channel will have obvious beneficial impacts upon human beings, buildings and structures by helping to prevent the occurrence of flood. At the same time there may be adverse impacts upon channel morphology, water quality, the landscape and wildlife, although these may be offset by mitigation or enhancement measures.

### 5.2.1 Channel morphology

In wet flood diversion channels, the routing of some water flow under normal conditions to a separate course may reduce water depth and flow velocity within the existing channel. This is likely to cause increased sediment deposition which may affect any existing pool-riffle sequence. Stabilisation of river depth and flow under the new flow regime may result in undercutting of existing bank features and erosion of previously stable areas of bank and river bed. Channel instability caused by diversion may result in a need for additional bank protection measures.

Introduction of normal diverted flow from a diversion channel to an existing watercourse may cause localised deposition of sediments, although this will depend on the bed characteristics of the diversion channel. The emergence of floodwaters from a diversion channel into an existing river channel may cause severe localised bed and bank erosion, with subsequent deposition of material downstream.

Where a dry flood diversion channel is created, only high flows from a river will be diverted and under normal flow conditions the diversion channel will be waterless. The impacts on channel morphology referred to above will not then apply. However, considerable sediment and debris input into a river may be expected where a vegetated dry flood diversion channel accepts a proportion of river flow under flood conditions. This will result from the entrainment by floodwaters of the natural accumulation of dust, soil and vegetable debris within the dry diversion channel. This material is likely to be deposited in the main channel downstream of the floodwater diversion.

### 5.2.2 Water quality

If normal flow in an existing watercourse is reduced by a wet flood diversion channel, changes in the surface area/water volume ratio may cause a decreased oxygenation of the water. This may be exacerbated by a reduction in water turbulence. Eutrophication of river water may occur as a result of decreased flow and increased sedimentation, as these conditions may encourage algal growth.

### 5.2.3 Landscape

A flood diversion channel is likely to have a significant effect upon the landscape in terms of visual impact and amenity. These impacts may be beneficial or adverse depending on the design of a scheme. The creation of a new watercourse, as a wet diversion channel, presents an opportunity for environmental enhancement and appropriate measures are suggested in a following section of this guidance. It is NRA policy to identify and promote enhancement of the aquatic and associated environment in its operational and regulatory activities (NRA, 1993).

### 5.2.4 Wildlife

Reduction of water depth and velocity within an existing watercourse by a wet flood diversion channel may affect instream flora and fauna. Decreased water depth in the natural channel may cause direct loss of existing edge habitat. Areas of emergent vegetation may dry out with consequent changes in the existing feeding or breeding habitat of invertebrates, fish and wildfowl. A lower water depth may cause damage to submerged plants whose structure requires physical support from the water column and be detrimental to invertebrates and fish that feed within such vegetation. At times of relatively low water, if a proportion of flow is diverted from an existing river, water depth may decline to such an extent as to be inadequate for maintenance of aquatic life. Fish, in particular, may be affected by a reduction in water depth and the community may change in composition, diversity and numbers.

Decreased water velocity may alter the species composition of existing flora and fauna. Macrophytes, invertebrates and fish which have adapted to moderate or fast river flow may be replaced by other species adapted to still or slow moving waters. The increased sedimentation associated with reduced flow velocity may dramatically alter the plant and invertebrate communities in some reaches. It is possible that sedimentation could cover gravels used as fish breeding or spawning areas.

Fluctuation in water levels would be reduced by the presence of either wet or dry flood diversion channels. This may create a degree of uniformity within the aquatic community of a watercourse and the species diversity of both flora and fauna may be modified.

## 6. Mitigation measures

Measures to mitigate the environmental impacts of a flood diversion channel include those which may be incorporated into the design of the new channel and those to avoid or reduce impacts upon the existing river. Some of these are discussed by McDonald & Rickard (1992) and many suggestions are provided in *The New Rivers and Wildlife Handbook* (RSPB *et al*, 1994).

### 6.1 Diversion channel

- A wet channel should be the preferred option if sufficient flow is available for diversion in the main river.
- The new channel should seek to mimic a natural watercourse typical of the locality, with a complex and varied structure.
- Diversion channel design should incorporate variations in flow, depth and width to provide a variety of habitat types.
- Materials used in channel construction should be environmentally appropriate and include timber and local rock rather than concrete or sheet piling wherever practicable.
- Working practice should attempt to ensure minimum disturbance to local residents and existing environmental features.
- Landscape plans should be formulated to minimise the visual impact of artificial structures such as flood walls and bank protection.
- If the channel passes through contaminated land a clay lining should be inserted.
- A riffle/pool structure should be created within the channel to ensure variation in sediment size, current velocity and channel profile. Pools will also provide a habitat for fish during periods of low flow.
- Gravels exposed by excavation may be left *in situ* to provide riffle habitat; alternatively a substrate of appropriate grain size may be imported.
- Bank slope should vary to provide diverse habitats for aquatic and riparian species.
- The new channel should be filled gradually as water is available from the main river.
- Channel slope should be staged, with gradients not exceeding 1 in 3.
- Groynes may be used to narrow the channel and increase water velocity at low flows.
- Shallow weirs may be used to retain a minimum depth of water over the whole length of the diversion channel.
- Creation of instream islands can be used to retain mature trees which would otherwise be lost. Introduction of a slope on one side of an island can provide an opportunity for marginal planting.
- Mature trees along the route should be left standing where possible.
- Newly cut banks should be sown with grass seed to assist stabilisation.
- A range of appropriate riparian vegetation, including aquatic plants, grassland, scrub, hedgerow and woodland should be established along the channel corridor.
- A management plan should be formulated for the vegetation and channel, and a maintenance programme implemented.

### 6.2 Existing channel

- Diversion of river flow should be controlled so that it is never reduced to an unacceptable level.
- Groynes may be inserted into the existing river to narrow the channel and increase river

velocity at low flows.
- Where riparian vegetation is lost through development activities, this should be replaced with appropriate species.
- The profile and bed of an existing river should be protected against erosion at the confluence with a diversion channel.

## 6.3 Enhancements

- Provision of features such as a pond dipping platform or angling access within the scheme can enhance the utility and recreational value of a site.
- Habitat features such as kingfisher banks could be created within the new channel.
- Existing natural features such as old tree roots should be retained where possible to avoid uniformity.
- Marginal shelves can be incorporated into the design of a new channel.
- Bird and bat boxes can be installed on existing trees and structures.

## 7. Baseline surveys

The type of baseline information suitable for use in EA of a flood diversion channel will vary with location and the proposed scheme. In general the following information would be required:
- Terrestrial habitat survey, including tree survey, of the river and proposed new channel.
- Geomorphological survey of the existing river.
- Survey of existing aquatic flora and fauna.
- Survey of fish populations and fishery activities within the area.
- Information concerning water use and recreation activities near the site.
- Amenity and visual characteristics of the landscape.

## 8. Monitoring

On-site supervision of working practices by an environmental specialist should be arranged, particularly if sensitive habitats or species are present.

An appropriate monitoring strategy should be developed to confirm the predicted impacts of the new channel. In particular, changes in river morphology and sediment distribution after completion of the project should be monitored for several years. Establishment of new vegetation along the channel corridor should be assessed, as should the effectiveness of mitigation measures.

## 9. References and guidance

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

National Rivers Authority (1993) NRA Conservation Strategy. NRA, Bristol.

McDonald, C. & Rickard, C.E. (1992) Diversion of the River Calder at Welbeck: An engineering and environmental challenge. *Journal of the Institution of Water and*

*Environmental Management* 6: 55-63.

Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

**9.1 Environmental Statements**

National Rivers Authority (1990) Environmental Statement for the River Wandle Flood Alleviation Scheme Contract 1. NRA Thames Region, London.

National Rivers Authority (1992) Stanwell Diversion Channel. Environmental Report to Accompany an Planning Application. NRA Thames Region, Reading.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CHANNEL WORKS (INCL. FLUVIAL DREDGING)

## 1. Introduction

This guidance note seeks to identify the potential impacts on the environment of river channel works, including fluvial dredging. It is intended to act as a general scoping brief for environmental impact studies of such operations.

The National Rivers Authority (NRA) has statutory responsibilities under the Water Resources Act 1991 for flood defence, navigation, fisheries and conservation of the aquatic environment. In order to fulfil these responsibilities the NRA must frequently undertake fluvial maintenance works to preserve the flood capacity navigation channels, visual amenity, conservation value or geomorphic stability of managed river channels.

Channel works usually involve the widening, straightening and/or deepening of river channels, or the removal of excess silt or in-channel obstructions. Such works are undertaken on a large scale by the NRA on a daily basis across England and Wales. The main intention of such operations is to minimise the risk of flood and to allow the passage of vessels. Private developers, local authorities and Internal Drainage Boards may also undertake channel works.

The environmental impact of some types of channel maintenance work is dealt with in other guidance notes of this series. The impact of vegetation management is described in Guidance Note 45 and that of bank protection in Note 32.

## 2. Development control

Channel works fall under the Town and Country Planning (General Permitted Development) Order 1995 (SI 1995 Nº 418) for the purpose of development planning. This allows permitted development rights to the NRA and other statutory undertakers for development in, on or under any watercourse or land drainage works that is required in connection with the improvement, maintenance or repair of that watercourse. Similar permitted development rights are given to statutory undertakers in respect of inland waterways (other than a commercial or cruising waterway) to which section 104 of the Transport Act 1968 applies.

The above permitted development rights may be modified under the Town and Country Planning (Environmental Assessment and Permitted Development) Regulations 1995 (SI 1995 Nº 417) if the proposed works meet the statutory criteria for environmental assessment (EA). A decision whether or not to permit a development can only be taken by an appropriate authority after consideration of an environmental statement. The authorising authority for such channel works is the Ministry of Agriculture Fisheries and Food (MAFF) where control is exerted through the provision of grant aid.

Channel works proposed by a developer who is not a statutory undertaker, perhaps as a part of a larger development, will require planning consent from a local planning authority under the Town and Country Planning system. The NRA is a statutory consultee under the Town and Country Planning (General Development Order) 1989 (SI 1989 Nº 1590) for development involving works or operations in the bed of, or on the banks of a river or stream.

## 3. Environmental Assessment

Most channel works fall into the regulatory category of "drainage improvement". In relation to fluvial maintenance this includes works which deepen, widen, straighten or otherwise improve any existing watercourse, or remove or alter sluices, weirs or other obstructions to watercourses.

The Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations 1988 (SI 1988 Nº 1217) provides a statutory procedural requirement for EA to be followed by any drainage authority undertaking drainage improvement works. This procedure specifies that an EA be conducted where the proposed works are likely to have a significant effect on the environment by reason of their nature, size or location. It is for the drainage body, which may be the NRA, an Internal Drainage Board or local authority, to determine if an EA is warranted.

The requirements of SI 1217 were slightly modified by the Land Drainage Works (Assessment of Environmental Effects) (Amendment) Regulations 1995 (SI 1995 Nº 2195). The drainage body must give notice in the local press of any land drainage improvement works, including channel works, with a statement as to whether or not an EA is to be carried out for the proposed project. Specified consultation bodies, such as the Nature Conservancy Council for England, the Countryside Commission and the Countryside Council for Wales must be informed directly. The amendment provides an opportunity, where the drainage body has decided an EA is not warranted, for any person to make representations to that body within 28 days after publication of the notice in relation to the likely environmental effects of the proposed improvement works.

It is NRA policy to undertake some form of EA for all channel works to ensure its operational activities do not conflict with its statutory obligations toward environmental protection and conservation. The information obtained may be used as a written justification for minor works, where this is required.

There is no statutory requirement for EA of channel works proposed by a private developer under the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1199). However, if channel works form an integral part of a larger development identified in the Regulations, an EA of all components of that development would be required.

Even where no statutory requirement for the EA of channel works proposed by a private developer exists, it may be worthwhile to undertake such an assessment. The NRA, as consenting authority for such works (see next section) may request that environmental information be made available in order to determine an application. Such information may be necessary for the NRA to fulfil its duties under the Water Resources Act 1991. An EA may provide the most appropriate method by which a developer may collate relevant information.

It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement, whether required by Regulations or not, follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consent

Channel works undertaken by an external developer will require prior consent from the NRA under Section 109 of the Water Resources Act (1991) for watercourses classified as main river, or consent under Section 23 of the Land Drainage Act (1991) for unclassified watercourses.

## 5. Major potential impacts

The potential environmental impacts of channel works are presented here under two major operational headings, that of channel widening or realignment and that of fluvial dredging. While this guidance concentrates on potential adverse impacts, channel works will also provide significant beneficial impacts for the issues they are designed to address. The risk of flood may be reduced and navigation made safer by such operations. In some cases, dredging or de-silting can improve fishery habitat by increasing water depth and exposing gravels for spawning.

### 5.1 Widening or realignment of channels

Channel works involving widening or realignment are often associated with fluvial dredging and potential impacts listed under that heading are also relevant to these projects.

**Landscape/archaeology**
Alteration of channel width or direction may result in land-take directly adjacent to the existing watercourse. This may be agricultural land, natural habitat, residential gardens or commercial property. The land-take may be temporary, for the duration of works, or permanent.

Sites of environmental, archaeological or historical interest may be affected by land-take or the use of machinery for widening/realigning a channel. Lasting damage or disruption to such sites should be considered a very significant adverse impact.

Channel modification and/or use of land by machinery during channel works may cause adverse impacts to landscape character. This may take the form of loss of natural features or features of visual interest, loss or change in vegetative cover or change in landscape diversity. Construction works themselves are likely to be intrusive in any landscape setting. These potential impacts apply to the local river corridor landscape, the wider catchment landscape and, where channel works are undertaken in built-up areas, to the urban landscape.

**Human beings**
Works may cause disturbance and disruption to local residents, businesses and users of the area. This may be caused by noise or dust emanating from construction activities, or by closure of roads or footpaths while channel works are undertaken. The works may

result in a temporary loss of amenity for river users, and boat moorings or other facilities may be inaccessible for a time. This could result in commercial losses, where angling or boat mooring revenue etc. is forfeited.

**Ecology**

Channel widening or realignment would cause disturbance or destruction of riparian habitat. This may include the loss of mature trees and other vegetation that may act as breeding or feeding sites for wildlife, including birds, and provide shade to the river. Reduction in shade may locally increase river water temperature. Loss of riparian habitat from a change in channel morphology may be exacerbated by the creation of an access route and use of heavy machinery along the channel. Compaction of topsoil is likely to occur and unfelled trees may be damaged by comprehensive trimming and lopping of branches to allow access.

**River morphology**

A change in river channel morphology may either speed up or slow down river flow, according to the type of scheme undertaken. The first instance may cause increased bed erosion in the vicinity of the works with associated increased material deposition downstream. Alternatively, if river flow is slowed by channel works, there may be increased deposition of mud and silt within the development site after works are complete. Either scenario can result in a substantial change in channel bed characteristics both upstream and downstream. Increased erosion or deposition may disturb or destroy existing benthic and emergent habitats and create bank instability.

Future maintenance requirements and/or costs could be affected by any change in river morphology. This could exert an indirect impact on flood defence, navigation and environmental concerns.

## 5.2 Fluvial dredging

Dredging is used for deepening channels or removing obstructions such as silt that have accumulated in a watercourse. This cannot be undertaken in a sympathetic manner and it is therefore important to assess the need for dredging rather than to undertake it as a fixed routine. The potential impacts described here arise from fluvial dredging using excavators, which may be undertaken from the river bank or a floating platform. Impacts of suction dredging are described in guidance note No. 40 of this series.

Access routes and heavy machinery used for dredging may cause adverse impacts to human beings, riparian vegetation, landscape features, sites of archaeological interest and the recreation value of an area, as described in the previous section.

**Hydrology/Morphology**

The excavation of a river bed is likely to cause suspension of sediments with downstream deposition during the course of works. In some watercourses it is possible that contaminated sediments trapped in the river bed will be re-suspended by dredging operations. Excavations may result in damage to natural channel morphology and loss of morphological variability. A fall in bed level may cause channel adjustment up and downstream, loss of pool-riffle sequences and bank instability.

**Ecology**
Major disturbance of the river channel bed is likely to result in both short-term and long-term damage to the ecological value of a watercourse. During dredging operations benthic flora and fauna will suffer disruption or destruction both at the dredging site and downstream, where considerable siltation may occur. Fish spawning may be interrupted and fish eggs or juveniles damaged by material deposition on spawning grounds. In the longer term, change in the substrata of a river bed may result in a reduction of ecological diversity and loss of fish spawning gravels and/or plant cover.

Increased suspended sediments during dredging operations may cause direct damage to fish gills and cause suffocation. These may also reduce light penetration in water and coat vegetation, thereby reducing photosynthesis and plant growth.

The potential ecological impacts of fluvial dredging depend on the techniques used. If the hard bed is unbroken by dredging then plants recover quickly; if the bed is destroyed but silt accumulates then plants may invade (Haslam, 1978). However, if the substrate is unstable following works, and there is no associated sediment deposition, then vegetation returns only very slowly (Brookes, 1988).

**Spoil disposal**
Spoil disposal is a major component of dredging operations and may pose serious environmental problems. If spoil is dumped at river margins the potential impacts include complete destruction of riparian habitat, loss of visual amenity, long-term sediment input to the watercourse and bank instability. If spoil is removed to another site, its transport may cause considerable noise and dust impacts to local residents. Spoil transport may also cause impacts at the receiving site, which should be investigated in an EA of such proposals.

## 6. Mitigation measures

Mitigation measures for the potential impacts of channel works are presented here for the construction/excavation and end-state phases of the operation. Some options for the enhancement of channel works sites are also provided.

**Construction**
Potential adverse impacts of the construction/excavation phase of channel works may be avoided or reduced by:
- Adoption of working practices that follow the appropriate NRA guidelines (NRA, 1994).
- Undertaking construction work only during normal working hours on weekdays. Local residents should be fully informed about the nature and timing of all works.
- Minimising impacts of works, such as noise, visual disturbance, dust etc. on the local community or landowners.
- Using temporary matting to reduce vehicle axle loads on the ground surface along temporary access routes to minimise disruption of vegetation.
- Minimising visual impacts of construction works on landscape or townscape character as much as possible.
- Minimising excavation and dredging wherever possible.

- Working from one bank would reduce disturbance and retain areas to act as a basis for recolonisation.
- Phased working, such as dredging in small sections or part of channel, would allow refuges for plants and animals to be retained and assist subsequent re-colonisation. This may take the form of dredged strips across or along one side of the channel, or in a zig-zag pattern up the channel.
- Phased flooding of a newly-constructed channel in order to minimise release of fine solids.
- Minimising downstream siltation by construction of a temporary silt and sediment trap.
- Undertaking works at periods of low flow within rivers to minimise silt disturbance.
- Undertaking dredging within inshore coastal waters, estuaries or the tidal reach of rivers on the ebb tide.
- Avoiding sensitive periods, such as the fish spawning and bird breeding seasons.
- Dredging in an upstream direction, so plant roots and animals which are dislodged during excavation can drift and re-colonise sections already completed.
- Storing the top layer (c. 20cm) of substratum in water and replacing it after dredging is complete, to assist invertebrate and plant recolonisation.
- Working from the river or around trees to avoid tree loss in appropriate areas.
- Ensuring tree surgery is planned in advance, undertaken in the appropriate season, and is carried out with the assistance of a qualified arboreculturalist.
- Avoiding sensitive habitats and trees wherever possible.
- Transplanting and storing vegetation for on-site replacement.
- Spoil from river dredging may have commercial value as an aggregate or fertiliser and should be disposed of in this manner where possible.

**End-state**

Long-term adverse impacts of channel works may be reduced and the water environment enhanced by the:

- Creation of a natural non-uniform and asymmetric channel.
- Retention of natural bank profiles, which should be reinstated at the new level where possible, leaving a surface of a varied, or diverse nature.
- Creation of marginal shelves to assist habitat diversity.
- Recreation of pools and riffles and reintroduction of native aquatic species.
- Retention of natural river banks where possible, and the use of sympathetic design and materials where revetments for bank stabilisation are necessary. Information on some appropriate techniques and materials are provided in *The New Rivers and Wildlife Handbook* (RSPB *et al*, 1994).
- Creation of artificial pools, riffles and point bars to simulate the morphology of a "natural" river. Pools should be located on the outside of bends. Gravels excavated from pools can be used to form riffles.
- Use of groynes to narrow overwidened low-flow channels to natural width.
- Use of groynes to direct flow around islands and create asymmetric flow patterns.
- Replacement of river gravels with substrate of similar composition and grain size.
- Use of appropriate materials, suited to the locality, for the construction of hard structures. Where reconstituted stone or concrete products are used, a dark colour may be least intrusive, although this will depend on the situation.

**General**

- Appropriate landscape features should be reinstated wherever possible.
- Replacement planting should be undertaken with appropriate species. Non-local species should be used only where necessary as a 'nurse crop', and where natural succession will rapidly result in their disappearance.
- Buffer zones could be created, with the agreement of landowners.
- Habitat features, such as old tree roots, should be retained to avoid uniformity.
- Groynes can be used to narrow channels and increase river velocity at points of low flows. This can improve habitats for fish and other aquatic flora and fauna.
- Bird and bat boxes can be installed on existing trees and structures.
- Fences should be erected at vulnerable locations to reduce dumping of rubbish and debris into the river and to discourage grazing or trampling of sensitive areas. These will also allow the natural regeneration of trees and shrubs.
- Creation of in-stream islands can be a means of retaining mature trees which would otherwise be lost. Introduction of a slope on one side of an island can provide an opportunity for marginal planting.
- Some areas may be flooded for wetland creation.

## 7. Baseline surveys

The type of baseline information suitable for use in EA of channel works will vary with location and the proposed scheme. In general, a thorough geomorphological survey of the watercourse and river corridor survey (NRA, 1992) of reaches to be directly affected by construction activities would be required for all projects. These surveys should extend downstream for an appropriate distance.

Where major channel works are involved, a comprehensive survey of aquatic, marginal and riparian habitats and species must be considered essential for any EA. In waters having a high fisheries value a survey of fish stocks should also be made. All major channel works would generally require a river landscape assessment (NRA, 1993) to be carried out and an archaeological appraisal of a site prior to commencement of works would be prudent.

Other information may be required to address local topics of concern. These could require data concerning issues such as surface water quality, downstream water use, water-related recreation and navigation use.

## 8. Monitoring

On-site supervision of working practice by an environmental specialist should be arranged if sensitive habitats or species are present.

An appropriate monitoring strategy should be developed to confirm the predicted impacts of the works. In particular, changes in river morphology and sediment distribution after completion of the project should be monitored for several years. The effectiveness of mitigation measures should also be assessed. Periodic monitoring surveys should be undertaken to evaluate the establishment of a new river morphology and recovery of riparian habitat and aquatic ecology. "Before" and "after" studies of fluvial dredging operations may assist in the critical assessment of the need for dredging.

## 9. References and guidance

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National Rivers Authority (1993) *River Landscape Assessment: Methods and Procedures.* Conservation Technical Handbook No. 2, NRA, Bristol.

National Rivers Authority (1994) *Works In, Near or Liable to Affect Watercourses.* Pollution Prevention Guidelines No. 5, NRA, Bristol.

Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

### 9.1 Environmental Statements

National Rivers Authority (1990) Environmental Statement - Ravensbourne Flood Alleviation Scheme, NRA Thames Region, Reading.

National Rivers Authority (1990) Environmental Statement - Wraysbury Diversion at Poyle. NRA Thames Region, Reading.

National Rivers Authority (1990) Environmental Statement - Colne Brook Regrading. NRA Thames Region, Reading.

National Rivers Authority (1992) Written Justification Prepared for the River Crane: Bath Rd. NRA Thames Region, London.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF BANK PROTECTION

## 1. Introduction

This guidance note seeks to identify the potential impacts of bank protection works upon the water environment. It is intended to act as a scoping brief for environmental impact studies of such development. The National Rivers Authority (NRA) has an interest in bank protection due to its statutory responsibilities for the protection and conservation of the water environment, navigation and flood defence. It takes the role of competent authority in the determination of land drainage consent for proposed bank protection works.

The aim of bank protection works is usually to renew or strengthen the walls and banks of a watercourse which are in an unstable state. Such action may be required if bank erosion threatens the land or property of riparian owners, roads or railways, the safe passage of vessels in navigable waterways or increases the risk of flooding. Riparian owners are responsible for protecting their own property against erosion, while the NRA is responsible for bank protection relating to flood defence and navigation concerns. The NRA may undertake bank protection work in order to meet these statutory obligations.

Bank erosion is a natural process caused by normal river flow. It may, however, be exacerbated by high flow velocities. Bank erosion may also result from, or be enhanced by, water seepage, wind, waves, tidal scour, boat wash or trampling.

Natural bank erosion and the subsequent deposition of eroded material adds variety to the river morphology and landscape. The necessity for bank protection should therefore be assessed before works are considered and would usually be appropriate only where property, structures or river access are under threat. The type of bank protection appropriate to a particular situation will depend on the nature of erosion and site characteristics.

A wide range of techniques and materials are available for the purpose of river bank protection. These may be loosely classified into hard, intermediate and soft protection methods. Some examples are listed below but this is not intended to comprise an exhaustive list. A comparison of alternative protection methods and their effectiveness has been made (NRA, 1991a) and general guidance is also available (NRA, 1994a). A detailed account and evaluation of bank protection methods used in the Broadland rivers of Norfolk has been compiled (NRA, 1995).

### 1.1 Hard protection

Hard revetments, such as concrete, sheet steel pilings or wooden pilings can be used to provide a vertical wall on a river bank that offers protection against erosion. Vertical revetments may also be necessary where navigation width needs to be maintained, or for boat mooring. Sheet steel piling or concrete offer a very heavy duty shield and are effective where there are buildings close to a river whose structural stability must be protected, or where there is a severe attack from currents or boat waves. For environmental reasons the use of hard revetments is discouraged by the NRA (NRA, 1994a) but in some situations, such as deep tidal waters, heavyweight steel piling or concrete is often the only protection technique that can be justified in terms of cost effectiveness.

Wooden boards with stake supports can be installed where lack of space demands a vertical shield. These are typically up to one metre in height. Logs or branches may be used in the same way. The back-fill to such low-level piling may be vegetated.

Gabion baskets or mattresses and concrete bag or block work provide a hard interface between a river and bank that may be contoured to provide some degree of bank slope. Open-cell concrete blocks which allow vegetation growth within the voids can be used in the same manner. Riprap, consisting of loose irregularly shaped natural stone, may be placed on a natural bank slope to provide protection. An underlay of sand/gravel is often used and a geotextile filter may be incorporated into the design. The performance of riprap as a form of bank protection is assessed by Doyle (1992). Groynes of various material may be used within a watercourse as a protection against eroding currents.

### 1.2 Intermediate protection

These techniques are intended to provide physical protection for a river bank, yet at the same time possess some natural characteristics. Willow spiling (woven willow branches) can be used to form a fence-like structure at the water/land interface and after some time the roots and sprouts will provide a living protection and additional stability. Although this technique is suitable for the protection of steep or vertical banks, it is not suitable as a retaining structure. It will also require some degree of maintenance.

Geotextiles are flexible fabrics or matting that may be placed to cover an eroding bank slope of moderate gradient. The relatively versatile nature of the material allows the matting to be laid over irregular surfaces, thus preserving a natural bank contour. Biodegradable geotextiles made of natural materials such as jute and coconut fibre are available; these allow colonisation by plants that eventually form a protective layer.

Willow faggots may also be used as a natural form of bank protection. Faggots trap silt and an eroding bank may stabilise and become consolidated through accretion. This technique is suitable for shallow or moderate bank slopes. The use of reed rhizomes, either placed under geotextiles or used on top of backfill material, particularly behind low-level piling, has also proved successful (NRA, 1995).

### 1.3 Soft protection

Reed and/or willow planting provide a form of bank protection that seeks to emulate natural conditions. These are very effective at absorbing waves and can be an attractive way of achieving protection while creating wildlife habitat. Reeds and/or willows may be planted within gabions, used as toe protection in pockets of geotextiles or at the foot of shallow berms. Further details of bank protection by willow planting are given in Vansplunder *et al*, (1994) and an assessment of the effectiveness of various vegetation and structural configurations is provided by Shields *et al*, (1995).

Grass planting may be used to assist stabilisation of an eroding bank and recommended species mixes for various situations are provided in NRA (1991a).

## 2. Development control

Bank protection schemes within a watercourse are not generally subject to local authority planning control, except where revetment works are constructed on a main river. Planning consent under the Town and Country Planning framework may also be required if, for example, any bank protection work comprises part of a larger development proposal, or if the proposed works are within a region designated as a SSSI. The NRA is a statutory consultee under the Town and Country Planning (General Development Order) 1988 (SI Nº 1813; NRA substituted by SI 1989 Nº 1590) for development involving works or operations in the bed of, or on the banks of a river or stream.

## 3. Environmental Assessment

Bank protection works undertaken by drainage authorities, including the NRA, fall under the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1217). These Regulations place an obligation on all statutory drainage authorities proposing to carry out any improvement works on a watercourse to undertake a prescribed procedure. The drainage body must consider whether, by reason of its nature, size or location, the proposed project is likely to have significant effects on the environment and ought therefore to be made the subject of an environmental assessment (EA). The drainage body must give notice in the local press of any land drainage improvement works, including bank protection projects, with a statement as to whether or not an EA will be carried out for the proposed project.

The conduct of an EA and subsequent preparation of an Environmental Statement should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

There is no statutory requirement for EA of bank protection works proposed by a private developer. However, the NRA, as consenting authority for such works (see next section) may request that environmental information be made available in order to determine an application. Such information may be necessary in order for the NRA to fulfil its duty to further the conservation and enhancement of natural beauty in respect of proposals relating to its functions. An EA may provide the most appropriate method by which a developer may collate relevant information.

## 4. NRA consents

All bank protection works require Land Drainage Consent from the NRA. This is most likely to be by virtue of the Water Resources Act 1991 but consents for certain works may be determined under the Land Drainage Act 1991 or the Highways Act 1980. The NRA's Land Drainage Bylaws may also be applicable to bank protection works in some areas of England and Wales.

Section 109 of the 1991 Water Resources Act requires the NRA to determine consents for the erection of any structure in, over or under a main river, or the alteration or repair of any such structure if it is likely to affect the flow of water. A similar requirement for

NRA consent applicable to bank protection works exists within the 1991 Land Drainage Act, which is concerned with "ordinary" watercourses (non-main river). NRA consents determined under the Highways Act relate to highway works carried out by Highway Authorities.

In addition to flood defence considerations, when considering an application for consent the NRA must also satisfy itself that any proposed works on a Main River or ordinary watercourse will not adversely affect the interests of fisheries or conservation.

## 5. Potential impacts

The form and severity of impact on the water environment resulting from bank protection works will largely depend upon the type of protection that is proposed and the characteristics of a development site and its surroundings. Potential impacts are described here under headings of hard, intermediate and soft forms of bank protection. An EA of any such development should consider its surroundings in the assessment of impacts as, for example, those impacts seen as significant in a rural setting may be different to those considered important in an urban environment.

The importance of design within bank protection schemes should not be underestimated. Certain bank protection techniques and materials are likely to be appropriate only under suitable hydraulic conditions or flow regimes. Poor design or the use of inappropriate construction methods or materials may in itself cause adverse impacts to riparian land or river features. Bank protection works should be designed to have a positive impact upon the erosion problem they are intended to address without compromising the adjacent morphology.

Bank protection works are likely to provide beneficial impacts through for example the protection of property, alleviation of flood risk and increased safety for users of the riparian and river environment. Some works, such as revetments, can provide recreational benefits in the form of boat moorings, angling platforms and improved pedestrian access, whilst others may provide opportunities to create new aquatic or riparian wildlife habitats. Although this guidance note concentrates primarily upon potential adverse impacts on the water environment, the beneficial effects of bank protection works should be included in an EA of any proposals.

### 5.1 Hard protection

Solid impermeable revetments, such as concrete walls or steel pilings, require the use of heavy machinery in their construction and may therefore cause disruption of river access and noise nuisance in the surrounding area. The erection of such bank protection is likely to result in complete destruction of some riparian, marginal and aquatic habitat.

### Hydrology/Geomorphology

Hard bank protection may alter the roughness or natural morphology of a river channel. Bank protection formed of a regular layer of concrete, steel or wood would usually reduce channel roughness and may increase water velocity. This can lead to river bed erosion with subsequent redistribution of sediments and change in the existing riffle/pool sequence. Conversely irregular revetments such as rip rap may increase roughness of a watercourse, thereby reducing water speed, resulting in deposition of suspended material. A hard bank protection structure is also likely to reflect waves and river energy which may cause erosion to occur on nearby unprotected areas of river bank.

Although a protective barrier using gabion baskets is relatively easy to construct and may vegetate up to a point, high walls may topple or lean into the river and their life span is variable depending on the corrosive power of the water. In the event of collapse, impacts upon river flood capacity, flow velocity and sediment distribution may be expected. Repair of such collapse would entail further impacts on the hydraulics and morphology of a watercourse.

Where groynes are used as a form of bank protection, flow velocity and channel roughness may be altered. This may cause bank instability in unprotected areas and increased bed erosion. They may also impede flow in flood conditions.

Impermeable bank protection such as concrete or steel sheet piling is likely to impede riparian drainage.

### Wildlife/fisheries

The vertical face of some hard bank protection schemes may produce an abrupt change between bank and river that provides little or no marginal wildlife habitat. Vertical banks may also curtail free access of wildlife from the river bank to the water.

Where a long stretch of bank protection is imposed there may be substantial disruption to river corridor habitat, including loss of refuge for fish and other wildlife during high flows and diminished shade from tree cover. The overall impact is that of a reduction in habitat diversity. Loss of marginal and bankside vegetation may reduce the available feeding and breeding areas for fish and birds.

Erosion or deposition processes arising from the hydrological or geomorphological impact of a hard protection scheme may disturb fish spawning gravels. The erection of protective structures may impede access to the water for fishing or recreation.

### Landscape

Hard revetments may cause an adverse visual impact to the landscape as they can be intrusive in a natural riverine situation and reduce its scenic complexity.

### 5.2 Intermediate protection

The use of bank protection materials such as woven hurdles, usually of hazel or willow, or biodegradable geotextiles offer several environmental advantages over hard protection techniques. Where a vertical shield is created, as in the use of spiling, it provides a microhabitat entirely lacking in concrete or steel structures. The subsequent rooting and growth of willow both strengthens the defence against erosion and offers an attractive new wildlife habitat. Biodegradable geotextiles offer similar advantages where willow poles are used as retaining stakes as these may be expected to root and grow. Nevertheless, intermediate bank protection techniques are suited only to certain circumstances, such as shallow water or gentle bank gradients, and are themselves likely to temporarily displace existing riparian and marginal habitat.

Most types of intermediate bank protection are likely to increase channel roughness, thereby slowing water flow and encouraging deposition of suspended sediments. The construction of intermediate bank protection and subsequent inspection or maintenance of materials such as geotextiles, willow spiling or faggots may cause disturbance to riparian and aquatic vegetation and wildlife.

### 5.3 Soft protection

Bank protection schemes that use planting of reeds or willows in shallow water can only be used where there is sufficient width of channel to allow rivers uses such as navigation, access for recreation and flood conveyance.

The growth of new vegetation along the margins of a river may obstruct flow downstream. In some situations, such as small watercourses, growth of willow from even a single bank may cause an unacceptable flood hazard.

## 6. Mitigation measures

Mitigation measures for the potential impacts of bank protection works are presented here for the construction/excavation and end-state phases of the operation. Some options for the enhancement of development sites are also provided.

Overall the primary means of mitigating impacts of bank protection is to use the "softest" technique possible, compatible with the degree of protection required. The NRA recommends that wherever possible, natural forms of bank protection or revetment are used, and that the use of hard man-made revetments is restricted to a minimum (NRA, 1994a).

In order to integrate the requirements of bank protection schemes designed to protect property, assist navigation or strengthen flood defences, with the aim of conserving and enhancing the natural environment, early liaison or consultation between the developer and other interested parties is recommended. Local NRA Conservation departments, voluntary organisations and members of a local community may all assist in the identification of key impacts and the design of suitable site-specific mitigation measures.

Many suggestions for minimising the impacts of bank protection works upon the natural environment are provided in *The New Rivers and Wildlife Handbook* (RSPB *et al*, 1994).

**Construction**
Potential adverse impacts of bank protection scheme construction activities may be avoided or reduced by:
- On site supervision of working practices to ensure they follow the appropriate NRA guidelines (NRA, 1994b).
- Limiting movement of construction plant and materials to normal working hours.
- Minimising the working area as far as is practicable.
- Avoiding sensitive periods, such as the fish spawning and bird breeding seasons.
- Undertaking river bed excavation work during a period of low flow to minimise silt disturbance.
- Avoiding sensitive habitats and trees wherever possible.

**End-state**
Long-term adverse impacts of bank protection works can be reduced and the water environment enhanced by:
- Careful design of any bank protection scheme to ensure it provides adequate protection where this is required, whilst minimising impacts on channel morphology.
- Keeping the length of any bank protection as short as possible, commensurate with its primary role.
- Retention of natural river banks where possible, and the use of sympathetic design and materials where revetments for bank stabilisation are necessary.
- Retention of natural bank profiles where appropriate if protective structures are to be erected.
- Reducing the height of river side walls as much as possible.
- The provision of terraces on hard structures to allow additional planting areas.
- The creation of marginal shelves beneath hard and intermediate structures.
- The use of local materials as cladding where hard revetments are erected.
- Aesthetic "softening" of hard structures by inclusion of morphological variability and vegetation in the design.
- The use of groynes only where flow regimes have been altered and natural processes cannot repair bank erosion.
- The design and implementation of an appropriate riparian landscaping scheme, including tree planting.
- The creation of areas of natural habitat within and adjacent to bank protection works.
- The formulation and implementation of a vegetation and general maintenance program for intermediate and soft protection schemes.

## 7. Baseline surveys

Hydrological and geomorphological surveys would be required as baseline information for EA of all large scale bank protection works. Small projects are likely to require site-specific information only. A river corridor survey (NRA, 1992) and/or habitat survey may be necessary in some situations, particularly where sensitive or rare species may be present. If such issues are relevant, data should be obtained on recreation and fisheries activity within a river corridor.

## 8. Monitoring and Audit

They key aim of a monitoring program of any bank protection works should be directed at examining the effectiveness of a scheme in reducing bank erosion. Monitoring of the geomorphological characteristics of a site and its environs would be necessary to determine whether bank erosion has been prevented and also whether or not erosion forces have simply been transferred elsewhere.

Where intermediate or soft protection schemes have involved habitat creation or vegetation planting, monitoring of their successful establishment should be undertaken.

## 9. References and guidance

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FLOOD STORAGE AREAS

## 1. Introduction

This guidance note seeks to identify the potential environmental impacts of flood storage areas and is intended to act as a general scoping brief for environmental impact studies of such developments. The National Rivers Authority (NRA) has an interest in flood storage areas due to its statutory responsibility for flood defence under the Water Resources Act 1991. This Act gives the NRA a duty to exercise general supervision over all matters relating to flood defence. The NRA may also undertake new flood defence works, including the construction of flood storage areas and in such instances must ensure all projects comply with the environmental requirements of the Act.

A flood storage area may also be referred to as a balancing reservoir, storage basin or balancing pond. Its purpose is to attenuate an incoming flood peak to a flow level that can be accepted by the downstream channel. It may also delay the timing of a flood peak so that its volume is discharged over a longer time interval.

Flood storage is often required as a result of increased run-off caused by catchment urbanisation. Impoundment capacity can be used upstream or downstream of developments to reduce water volume passing through channels that may be too small to accept extreme flows. In addition to the permissive powers of the NRA to construct flood storage areas on main rivers, developers and District Councils may seek to provide flood storage capacity on non-main rivers to attenuate an increased rate of surface water run-off from development areas. Whilst the NRA will assess the possible flooding effect of any development and make suggestions for any necessary remedial measures, such as the construction of a flood storage area, the onus is on the developer to determine the effect of his proposals on any watercourse and design works to offset this.

A flood storage area may take the form of a wet or dry reservoir. A wet reservoir is a water storage facility in which storage can be effected by allowing water levels to rise during flood times. A dry reservoir is typically adjacent to a river and comprises an enclosed area that accepts water only during flood peaks. Permanent wet reservoirs may offer recreational opportunities and amenity areas. Nevertheless, in some cases dry storage reservoirs, water meadows or nature conservation sites offer the preferable solution to flood storage, usually having lower maintenance and operational costs, as well as the opportunity for alternative use of the area when not required for flood storage (NRA, 1994a).

A storage facility may be 'on-line' (i.e. on-stream), causing backup of water above the control mechanism, or 'off-line', where water is diverted to a storage area adjacent to a (typically embanked) river. Both types of storage allow excess water to drain away at a controlled rate once a flood event is over. Depending on whether a flood storage area is wet or dry, on-line or off-line, its development may involve the construction of a dam on a watercourse, embankments surrounding a storage area adjacent to a river, excavation of a storage area adjacent to a river and/or associated control and pumping facilities.

## 2. Development control

New flood defence works, such as the construction of a flood storage area are subject to planning control under the Town and Country Planning system and a development proposal will therefore require consent from a local planning authority. The NRA is a statutory consultee to any proposed development in areas liable to flood or which might giver rise to drainage problems.

## 3. Environmental Assessment

The creation of a flood storage area may require an environmental assessment (EA) under the Town & Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI N° 1199). Flood relief works and installations designed to hold or store water on a long-term basis are identified in Schedule 2 of these Regulations as requiring EA if they are likely to have significant effects on the environment by virtue of factors such as their nature, size or location. The decision as to whether an EA is required rests with the local planning authority.

The construction of flood storage reservoirs and flood alleviaton works generally fall within the definition of "drainage improvement" and therefore within the ambit of the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations (SI 1988 N° 1217). These Regulations have been slightly modified by the Land Drainage Improvement Works (Assessment of Environmental Effects) (Amendment) Regulations 1995 (SI N° 2195). The Regulations place an obligation on any drainage body proposing to carry out certain drainage works to undertake a prescribed procedure. The drainage body must consider whether, by reason of its nature, size or location, the proposed project is likely to have significant effects on the environment and ought therefore to be made the subject of an EA. The drainage body must give notice in the local press of any land drainage improvement works, including flood storage areas, with a statement as to whether or not an EA will be undertaken for the proposed project. Compliance with this Regulation is a condition for grant aid from the Ministry of Agriculture, Fisheries and Food.

It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents/licences

NRA land drainage consent is required under Section 109 of the 1991 Water Resources Act for the erection or alteration of any structure designed to contain or divert floodwaters of any part of a Main River.

Land drainage consent is required from the NRA under Section 23 of the 1991 Land Drainage Act for the erection of any dam, weir or other obstruction to the flow of any ordinary watercourse (Non-Main River). NRA consent is also required by the Act for any drainage works carried out by a Local Authority against flooding on any watercourse. Consents under local NRA byelaws may sometimes be required.

Both wet and dry flood storage areas require impounding licences from the NRA, except for off-line dry reservoirs which are not classified as part of an inland water.

In exercising its powers in determination of consents the NRA is enjoined by the above Acts to promote the conservation and enhancement of the natural beauty and amenity of inland waters and land associated with these. It also has a responsibility to promote the conservation of flora and fauna which are dependent on the aquatic environment, and the use of inland waters and associated land for recreational purposes.

## 5. Potential impacts

The environmental impact of any flood storage area will depend to a large extent upon the type of scheme that is proposed; i.e. whether the facility is to be on-line or off-line, wet or dry. This guidance note examines the potential impacts of all types of flood storage area, including those associated with construction. These are presented as 'construction' impacts and 'end-state' impacts, where the latter describes the residual effects of flood storage area development.

Many of the potential impacts of any scheme are likely to be specific to a particular site and an EA must examine local conditions. Consultation with local community groups prior to project design is recommended, as is early discussion of possible impacts with relevant statutory organisations.

### 5.1 Construction

Guidance Notes No. 1 (General Construction) and No. 2 (Reservoirs) of this series are relevant to EA of flood storage area construction and should be consulted.

Whatever form of design is adopted for a flood storage area, the main elements of any construction will be broadly similar. These are the construction of either an excavated or earth-banked containment structure for an off-line scheme, or of an on-line balancing reservoir. Significant potential impacts arising from these activities may include:

- Destruction or disturbance of natural terrestrial habitat, such as woodland, grassland or hedgerows.
- Destruction or disturbance of natural aquatic, marginal and riparian habitat.
- Disturbance or loss of terrestrial or aquatic fauna and flora, which may include rare or protected species.
- Re-suspension of contaminated river bed sediments by dredging operations.
- Compaction of soil by heavy vehicles along access routes and within the development site.
- Destruction of terrestrial habitat and visual intrusion by disposal of excavated material, whether on-site or elsewhere.
- Disturbance or destruction of archaeological sites, or other sites of local interest.
- Noise disturbance to local residents and property by movement of plant and other vehicles.
- Creation of dust which may be blown to local residences or mud that may be spread to local roads by development traffic.
- Disruption to local traffic and pedestrian access near the development site.

## 5.2 End-state

Beneficial impacts of a flood storage area are primarily related to human beings in that such a development should decrease the risk to land, property and human life from periodic flood events. In some situations, particularly within urban areas, a flood storage area may also provide an area of natural habitat that is attractive to birds and other wildlife within an urbanised setting.

Although a flood storage area may have a number of beneficial impacts, this guidance note concentrates on the potential adverse impacts that may be inherent in any scheme.

### 5.2.1 Surface water hydrology

An on-line impoundment facility is likely to exert a dramatic impact on surface water hydrology. The magnitude, frequency and duration of flooding will be altered, as this must comprise the rationale for any scheme. In addition, flow velocities are likely to be reduced and riparian drainage affected.

An off-line storage facility may alter the level of a water table which in turn may increase the velocity of riparian drainage after heavy rainfall.

If a proliferation of flood storage areas were constructed within a catchment this could, in certain circumstances, lead to an enhancement of peak flows in watercourses downstream (NRA, 1994a), as a longer flood peak may provide a greater chance of co-incidence. The potential impact of both existing and possible future flood storage facilities should therefore be considered in relation to surface water hydrology on a catchment scale in an EA of any proposed scheme.

### 5.2.2 Surface water quality

On-line impoundment of flow may lead to a reduction in the downstream dilution capacity of a watercourse, although this is unlikely to prove critical as only peak flows would be modified. Some decrease in oxygenation of water may also occur. In the case of dry storage reservoirs, adverse impacts on water quality may result from a rapid growth of algae while water is stored and after release due to the high level of nutrients likely to be available within the impoundment.

### 5.2.3 Channel morphology

On-line impoundment of flow is likely to result in a change of river bed slope with consequent upstream and downstream adjustment of a channel, loss of pool-riffle sequence and bank instability. Deposition of mud, silt or heavier material is probable within the impoundment site over a period of time and this will exacerbate upstream and downstream channel adjustment. When an on-line impoundment is cleared periodically of sediments, further channel disturbance may occur and therefore long-term stabilisation of pools, riffles and channel sediments may not take place.

The periodic release of water from an off-line impoundment structure may cause localised erosion of river bed and/or bank at the point of discharge. Below this point the width and depth of a channel may be enlarged. Increased deposition of material downstream is likely to occur as a result of bed/bank erosion at the discharge point and also due to the abnormal sediment load likely to emanate from a dry storage facility that may be filled with water only occasionally.

### 5.2.4 Aquatic ecology

An on-line flood storage reservoir will cause water to back up and may permanently or periodically submerge existing marginal or riparian habitat. This may be detrimental to riverine and floodplain wildlife in the area of flooding if, for example, summer flooding, inundates wildfowl nesting sites. On-line impoundment may also affect fish behaviour and increased erosion or deposition may disturb fish spawning areas. An impounding structure is also likely to act as a barrier to mammal movement and fish migration.

Release of water from any flood storage area may disturb the flora and fauna at and below the point of discharge. There may be a loss of species sensitive to deep water or high water velocity. Periodic discharge of stored water may result in an unstable benthic community immediately below the discharge point.

A model relating species occurrence to physical habitat features has been developed (Hey *et al*, 1994). This can predict, at the design stage of a project, the likely response of a river to particular engineering works. This may be used for EA in terms of the effect of a flood storage scheme on river plant species.

### 5.2.5 Terrestrial ecology

Whereas a wet off-line impoundment may cause a permanent loss of terrestrial habitat, a dry reservoir will undergo periodic inundation and both agricultural land use and natural habitats would be affected. This may be seen as an opportunity for habitat creation or enhancement but attention must be given to adverse impacts caused by occasional inundation. For example, the breeding success of ground-nesting birds such as lapwing, redshank and snipe may be adversely affected by spring and early summer flooding (RSPB *et al*, 1994). Periodic flooding is also likely to disturb or destroy terrestrial communities of small mammals, crustaceans and insects living within the confines of a off-line flood storage area or adjacent to an in-stream impoundment.

An on-line impoundment may cause periodic flooding of riparian and terrestrial habitats adjacent to a river upstream of a dam. This may result in the loss of sensitive species, including trees.

A comprehensive review of the ecological effects of river regulation, including flood storage areas, on mammals and birds is provided by Nilsson & Dynesius (1994).

### 5.2.6 Land use

An off-line flood storage area will inevitably cause some degree of loss of agricultural or other land. In the case of wet storage, this will be permanent. In the case of a dry storage facility, although the land may be available for restricted agricultural use for much of the year, at some times it will be flooded. Riparian habitat may also be lost.

Any form of flood storage area will change the local flooding regime and this may adversely affect land use or land quality. The presence of an impoundment structure is also likely to place a restriction on future land development.

### 5.2.7 Landscape

The presence of embankments or an excavated impoundment facility may cause a considerable adverse visual impact to the landscape. Although this may decrease in the longer-term if suitable landscaping and vegetation schemes are implemented, some degree of adverse visual impact may remain as a permanent feature.

### 5.2.8 Recreation/amenity

Regulation of river flow may cause some change in the fish population, as an overall reduction in flow velocities is likely to inhibit salmonid species and hence reduce angling quality.

An in-stream impoundment may cause disruption to many recreational users of the water environment, including boating, although the degree of impact will depend on the existing recreational value of any site. This may also be off-set by the creation of new water-based recreational opportunities within a flood storage area.

## 6. Mitigation measures

Measures to mitigate the environmental impacts of a flood storage area include those which may be incorporated into the design of the impoundment facility and those representing environmental enhancements. Some of these are discussed in *The New Rivers and Wildlife Handbook* (RSPB *et al*, 1994) and examples are provided. A comprehensive guide to the environmental aspects of such facilities that are relevant to designers and engineers is provided by *Design of Flood Storage Reservoirs* (CIRIA, 1993). More general guidance for the design and construction of large engineering projects is given in CIRIA (1994a, b).

The most appropriate form and design of any flood storage facility can only be identified on a site-specific basis. Dry storage reservoirs have several advantages over wet storage facilities in terms of maintenance and operational costs. They also provide opportunity for alternative use of an area when not required for balancing floods. However, this form of flood storage facility may not always provide the most appropriate solution within a given situation. Water meadows and wetlands, for example, also possess a substantial flood absorption capacity. Care should be taken as to what type of flood storage area is to be created, as some forms are more intrusive upon the environment than others. The NRA is able to offer advice regarding the most suitable type of scheme for a specific development site within any river catchment, and prospective external developers should consult with the Authority at an early stage in project planning.

The most important mitigation measure to be undertaken in respect of flood storage areas is a commitment to ensure satisfactory long-term maintenance and future renewal of any impoundment facility. Flood storage areas are prone to deterioration as a result of loss of volume by siltation and by the growth of vegetation unless properly maintained. This issue should be addressed at the planning stage and may best be resolved by legal agreement.

### 6.1 Construction

Potential adverse impacts of the construction/excavation phase of flood storage areas may be avoided or reduced by:

- On site supervision of working practices to ensure the appropriate NRA guidelines (NRA, 1994b) are followed.
- Undertaking in-channel works at period of low flow to minimise silt disturbance.
- Limiting movement of construction plant and materials to normal working hours.
- Minimising the working area as far as is practicable.
- Avoiding sensitive periods, such as the fish spawning and bird breeding seasons.
- Avoiding sensitive habitats and trees wherever possible.

### 6.2 End-state

Long-term adverse impacts of flood storage areas may be reduced and the water environment enhanced by:

- The use of wetlands or natural flood plains as flood storage areas wherever possible. Where this is not practicable, an off-line storage facility is preferable. The NRA should be consulted as to whether a wet or dry impoundment area is the best environmental option for a specific site.
- Careful design of all wet impoundments with respect to access for desilting operations.
- The minimisation of embankment height as far as possible accompanied by appropriate landscaping to reduce visual impact.
- Minimising and possibly eliminating the use of hard finishes such as concrete. Alternatives such as geotextiles and wooden pilings should be considered.
- Grassing of spillways and overflow structures wherever possible.
- The creation of a bank slope no steeper than 1:5 on dry reservoirs to assist easy maintenance and reduce danger to children and animals.
- The creation of non-uniform impoundment embankments wherever possible, with miniature spits and bays.
- Creation of marginal shelves in wet storage areas to assist habitat diversity.
- Creation of wetland areas such as marshland, wet grassland, willow carr, fen or reed beds within wet storage embankments.
- The design and implementation of an appropriate landscaping scheme around any impoundment area. This should include tree planting of for example, willow and poplar, at vulnerable locations to provide shelter for wildlife from winter storms and to protect embankments from wind-driven wave erosion.
- The creation of areas of natural habitat adjacent to a flood storage area. This may require land acquisition for off-site habitat enhancement and also a commitment to future maintenance.
- The formulation and implementation of a vegetation and general maintenance program for the entire flood storage area complex.
- The formulation and implementation of a Water Level Management Plan that is able to integrate the requirements of flood defence with those of conservation and recreation interests.

## 7. Baseline surveys

A river corridor survey (NRA, 1992) will be required as essential baseline information for EA of a flood storage area. This should include identification of habitats, flora and fauna within and adjacent to the watercourse and proposed flood storage facility. Comprehensive hydrological and water quality data concerning the catchment and reach affected would also be necessary. A geomorphological survey of river sediments up and downstream of the proposed storage area should be undertaken.

Where a watercourse has value for fisheries or recreation, a survey of the existing opportunity for these activities should be made.

## 8. Monitoring

Hydrological monitoring of the affected reach should be undertaken as an on-going check of the effectiveness of any flood storage impoundment. An appropriate monitoring strategy should be developed to confirm the predicted impacts of the works on water quality, water flow, sediment distribution and the flora and fauna of aquatic and riparian habitats. The effectiveness of mitigation measures should also be assessed. Periodic monitoring surveys should be undertaken to evaluate the establishment of new riparian and aquatic habitat where this comprises part of a proposed scheme.

## 9. References and guidance

Construction Industry Research and Information Association (1993) *Design of Flood Storage Reservoirs*. Butterworth/Heinemann.

Construction Industry Research and Information Association (1994a) *Environmental Handbook for Building and Civil Engineering Projects: Design and Specification*. CIRIA Special Publication 97.

Construction Industry Research and Information Association (1994b) *Environmental Handbook for Building and Civil Engineering Projects: Construction Phase*. CIRIA Special Publication 98.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide*. HMSO, London.

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National Rivers Authority (1992) *River Corridor Surveys: Methods and Procedures*. Conservation Technical Handbook No. 1, NRA, Bristol.

National Rivers Authority (1994a) Flood Defence Technical Liaison Manual. NRA, Severn-Trent Region.

National Rivers Authority (1994b) Pollution Prevention Guidelines: Works in, near or liable to affect watercourses. PPG 5, NRA, Bristol.

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Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

**Environmental Reports**

National Rivers Authority (1991) Written Justification - Hartsbourne Stream Proposed Flood Alleviation Scheme. NRA Thames Region, Reading.

National Rivers Authority (1991) Environmental Report to accompany the planning application for the Stocklake Flood Storage Area: Aylesbury Flood Alleviation Scheme. NRA Thames Region, Reading.

National Rivers Authority (1991) Environmental Report to accompany the planning application for the Bear Brook Flood Storage Area: Aylesbury Flood Alleviation Scheme. NRA Thames Region, Reading.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF FLOOD EMBANKMENTS

## 1. Introduction

This guidance note seeks to identify the potential impacts arising from the construction of flood embankments. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such developments.

The NRA has a central role in flood defence concerns due to its statutory responsibilities set out in the Water Resources Act 1991, which gives it a duty to exercise general supervision over all such matters and specific permissive powers relating to flood defence works. In order to fulfil its obligations the NRA acts as competent authority for a wide variety of developments designed to protect the land surface against flood waters. Inland, such projects include river bank protection, flood embankments and flood diversion channels. The 1991 Act also imposes general duties on the NRA to promote conservation and enhancement of the natural beauty and amenity of inland waters and associated land, the conservation of flora and fauna dependent on the aquatic environment and the use of waters and land for recreational purposes.

Under Section 16 of the Water Resources Act and Section 12 of the Land Drainage Act 1991 the NRA is obliged, in formulating or considering any proposals relating to any of its functions, including flood defence, to take into account the effect which the proposals would have on the beauty or amenity of any rural or urban area or on any flora, fauna, features, buildings, sites or objects.

The purpose of flood embankments is to contain water within a river or floodplain area that may otherwise spill onto adjacent land. These are engineering structures and as such are designed for a particular task and to remain cohesive under load. Although their size, slope and vegetative covering may vary to take account of other issues such as grazing or access, their priority is to ensure that cohesiveness is retained, as embankment failure could result in flooding of property, injury or death. In rural areas flood embankments are usually associated with estuarine wetlands, river floodplains and other low-lying areas. Embankments may also be found in urban situations where they protect property within a floodplain from high river flows or tidal waters.

Flood embankments usually involve the construction of an impermeable bund of appropriate height, often overlain by topsoil and vegetation. Embankment material may be imported, excavated on site. An embankment may be placed very close to a watercourse where this is necessary in confined urban environments. In less confined areas a flood embankment may be set back some distance from a river to allow some limited flooding of land within its confines.

Flood embankments may be constructed by drainage authorities, including the NRA, as a part of flood defence works or for conservation purposes. An embankment may also be formed by a private developer seeking to protect an individual property from flood. This type of development may be undertaken in isolation or represent a single component of a larger flood defence scheme.

## 2. Development control

New flood defence works, such as the construction of an embankment are subject to planning control under the Town and Country Planning system and a proposal for such development therefore requires consent from a local planning authority.

## 3. Environmental Assessment

Flood embankments fall within the category of land drainage improvement for some regulatory purposes. The Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations (SI 1988 N° 1217) laid down a procedural requirement to be followed by any statutory drainage authority in respect of land drainage improvement works. This has been modified by the Land Drainage Improvement Works (Assessment of Environmental Effects) (Amendment) Regulations 1995 (SI N° 2195). The procedure specifies that an Environmental Assessment (EA) should be conducted where the proposed works are likely to have significant effects on the environment by reason of their nature, size or location. It is for the drainage authority to determine if an EA is warranted. The drainage body must give notice in the local press of any land drainage improvement works, including flood embankments, with a statement as to whether or not an EA will be conducted for the proposed project.

The creation of a new flood embankment by a private developer may require an EA under the Town & Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI N° 1199), as flood relief works are classified as Schedule 2 projects. The decision as to whether an EA is required under these Regulations rests with the local planning authority and is based upon the likelihood of significant environmental impacts resulting from the development.

Where a formal EA is not required by the above Regulations it is nevertheless good practice, as undertaken by the NRA, to conduct some form of assessment. Also, the NRA, as consenting authority for land drainage (see next section), may request environmental information concerning a specific development in order to determine an application for land drainage consent. This results from its duty under the 1991 Land Drainage Act to further the conservation and enhancement of natural beauty in respect of proposals relating to its functions. An EA may provide the most appropriate method for collating relevant information.

It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement, whether required by Regulations or not, follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

As the NRA is responsible for the planning and operational aspects of flood defence works and is also the authorising body for land drainage consents regarding designated main rivers, the question of NRA consent for embankments will be an internal matter when it takes the role of developer. If another drainage authority, such as an internal drainage board, local authority, or a private developer wishes to construct a flood embankment, consents under either Section 109 of the Water Resources Act 1991 (Main River) or Section 23 of the Land Drainage Act 1991 (Non-Main River) will be required from the NRA.

## 5. Major potential impacts

Creation of a flood embankment will produce many beneficial impacts such as a reduced risk of flood damage to land and property, and a diminished risk to human life. It may also lessen disruption of communications by floodwaters and improve access across a floodplain. These, and other positive impacts, will be implicit in the rationale of the proposed flood embankment project and are not examined here.

The major potential adverse impacts arising from the construction of flood embankments are due directly to the excavation of material for an embankment and its formation. Impacts are described here under headings of 'construction' which examines all activities relating to the creation of flood embankments, and 'end-state' which describes potential residual impacts.

This guidance note describes some of the potential impacts of flood embankments that may occur but cannot encompass every type of situation. The actual impacts likely to result from a flood embankment will depend to a large extent upon the individual circumstances of any project. Local geology and land use, aquatic and riparian habitats, fluvial geomorphology and river hydrology are just some of the factors that may vary considerably from site to site. An EA should take full account of the characteristics of a particular project and its surrounding environment in impact identification and evaluation.

Other guidance notes in this series relevant to flood embankments are:
- Guidance Note 1. - General Construction
- Guidance Note 32. - Bank Protection

### 5.1 Construction

Construction activities likely to result in environmental impacts are excavation of material, its transport and storage, and embankment formation.

#### 5.1.1 Excavation of material

The type of impacts likely to be caused by excavation activities will depend upon the source of construction material. If this is taken from a quarry, gravel pit or other mineral extraction facility at some distance from the project, then impacts may be caused by its transportation. These are likely to include atmospheric pollution, noise, dust and traffic congestion. Similar impacts will apply in the stripping of topsoil for covering an embankment but this may also affect terrestrial habitats and vegetation at the excavation site. An EA should include impacts arising from the procurement of topsoil in its analysis of impacts.

All types of embankment material excavation and storage are likely to cause impacts such as noise, dust, disrupted access and visual intrusion, although the degree of impact will vary with each excavation project. Similarly, all types of excavation are likely to cause disturbance of wildlife such as vegetation, birds and mammals, due to the creation and use of access roads, machinery noise and temporary storage of excavated material.

**Land excavation**
If embankment material is excavated from land close to a proposed river embankment this may alter surface water runoff and change the flow characteristics and level of underground water. The intensity of such impacts will depend on the characteristics of local geology, geomorphology and hydrology, and the depth and extent of any excavation site.

Complete destruction of terrestrial habitat or species is probable and this may be a matter for great concern in an area of nature conservation interest. Destruction or disturbance of habitats and species will be most intense in the area of excavation but would also extend to all access routes, material storage sites and delivery routes to the embankment under construction.

**Channel excavation**
This is not a preferred source of material, as excavation can significantly affect the fluvial environment. In addition the dewatering of excavated material would be necessary, potentially resulting in additional environmental effects. If material for embankment construction is excavated from any part of a river channel, this may result in considerable change to channel morphology and hydrology. A decreased flow velocity due to a greater depth or width of channel, may create a depositing environment where none existed previously. Disturbance of sediment by excavation in or at the margins of a channel is likely to cause increased water turbidity, suspension of material and subsequent downstream deposition. River bed slope may be altered by any excavation and this could disturb the riffle/pool sequence of a watercourse and cause channel adjustment up and downstream. It is possible that bank instability will occur in some areas due to erosion caused by changes in river depth and flow regime.

Channel excavation of material is likely to cause direct destruction or disturbance of aquatic and/or riparian habitat. This may include the feeding or nesting habitats of birds. Suspended material may cause harm to fish and exert an effect on fish behaviour. Downstream deposition of sediments may smother fish spawning gravels and cause loss of plant species sensitive to a depositing environment.

### 5.1.2 Formation of embankment

The construction of an embankment will result in loss of land that may have value for agricultural, recreational or amenity use. It will also cause direct destruction of terrestrial or riparian habitats and species with specific impacts depending on embankment siting. Issues of concern may be the loss of individual mature trees, woodland, hedgerows or meadow on land, and loss of reed beds or marginal plants close to water.

Where an embankment close to a watercourse is covered in topsoil, some may be eroded by rainfall and enter the river before it is stabilised by a covering of vegetation. This may result in a reduction of water quality by a high level of suspended solids, with associated impacts on wildlife, aesthetic appearance and recreational quality.

### 5.2 End state

A flood embankment is likely to change the existing surface water runoff pattern, both locally and within the catchment area affected, and may also modify riparian drainage into the embanked watercourse.

The structure may have a visual impact altering the local landscape and affecting views towards the site. The embankment may also restrict access to a water channel and cause disruption to public rights of way and users of the water environment.

## 6. Mitigation measures

The sensitive alignment of embankments relative to a river represents the most effective method of impact mitigation. Enhancement of embankments and enclosed areas for conservation interests is also desirable as a mitigation measure.

### 6.1 Embankment design

- An embankment should be set back from the watercourse wherever possible to reduce the risk of erosion and to increase floodplain storage capacity. This would also maximise habitat enhancement potential, reduce structural cost and facilitate easy future maintenance of the river and floodbank (RSPB *et al*, 1994).
- An embankment should be aligned as far as possible to avoid mature trees and existing wetland areas.
- A floodplain corridor within embankments may be used for recreation or establishment of wetland margins, backwaters, wet grassland, shrub or wet woodland.
- Embankments should be constructed with a varied profile, at least on its landward side, to avoid visual and habitat uniformity.
- Areas of embankments requiring revetment structures for erosion protection should be designed sympathetically and use local materials wherever possible. Concrete or sheet piling should be avoided.
- Where an embankment is constructed on the edges of a river channel, marginal scrapes should be incorporated into the design to encourage diversity of new habitat.
- Existing footpaths and other access facilities should be reinstated on completion of

works. These should be designed to blend with the local landscape. Where no access exists, design criteria can be used to enable cycling or walking on or adjacent to floodbanks wherever this is feasible.

- Intended vegetation management for embankments and enclosed areas should be incorporated into project design at the planning stage.
- New embankments should be planted with grasses as topsoil is laid to reduced the risk of soil erosion.
- Where existing vegetation is destroyed or disturbed, replanting of specific locations with appropriate species should be undertaken. Non-local species will be acceptable only where necessary as a 'nurse crop', and where natural succession will rapidly result in their disappearance.
- Livestock grazing should be used for embankment vegetation management where possible; this may benefit wildlife conservation and flood defence (RSPB *et al*, 1994). Where this is intended to occur, the design stage of a project must ensure embankment slopes are capable of withstanding load.
- Where mowing is used for vegetation management a balance should be found between the need for an early grass cut to meet flood defence criteria and a later cut to minimise disturbance of animals in their breeding season. Autumn mowing is recommended, although sufficient mowing to ensure integrity of grass cover is required in all cases.

### 6.2 Construction activities

- On site supervision of working practices should ensure they follow the appropriate NRA guidelines (NRA, 1994) are followed.
- The working area should be minimised as far as possible and it is preferable that works take place during autumn or winter to minimise damage to flora and fauna. However, it is recognised that such a timetable may not be practicable at sites where ground conditions would inhibit the construction of earth embankments during these months.
- Work should be undertaken only during normal working hours on weekdays.
- Local residents should be fully informed about the nature and timing of all works.
- Where excavation for material or embankment construction are in or adjacent to areas of nature conservation interest the use of temporary matting can reduce vehicle axle loads on the ground surface.
- Where excavation within a river channel absolutely necessary downstream siltation should be minimised by the construction of a temporary silt and sediment trap. This should be designed to allow the passage of fish wherever necessary.
- Topsoil stripped from the line of an intended embankment should be stored and used for subsequent covering to reduce the need for imported material.
- Stockpiling of construction materials should avoid sensitive habitats and areas of visual amenity.
- All land drains on the route of an embankment should be identified prior to commencement of works and repaired or replaced where they are disturbed by embankment construction.
- Temporary access routes should be created for the duration of works to replace those disrupted by embankment construction.

## 7. Baseline surveys

A comprehensive survey of terrestrial and riparian habitats, flora and fauna will provide necessary baseline information for an EA of a flood embankment. This should take the form of a river corridor survey (NRA, 1992) that includes the marginal, bank and floodplain zones.

Where material for embankment construction is to be excavated from any part of a river channel, geomorphological and ecological surveys of the watercourse will be required. Chemical analysis of sediments should be undertaken.

## 8. Monitoring

An appropriate monitoring strategy should be developed to confirm the predicted impacts of embankment works on water quality, water flow, sediment distribution and local habitats. The effectiveness of mitigation measures should also be assessed and should evaluate the establishment of new vegetation and recovery of terrestrial, riparian and aquatic habitat.

## 9. References and guidance

Brookes, A. (1988) *Channelised Rivers: Perspectives for Environmental Management.* John Wiley & Son, Chichester.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

National Rivers Authority (1992) *River Corridor Surveys: Methods and Procedures.* Conservation Technical Handbook No. 1, NRA, Bristol.

National Rivers Authority (1994) *Pollution Prevention Guidelines: Works In, Near or Liable to Affect Watercourses. PPG 5,* NRA, Bristol.

### Environmental Statements

National Rivers Authority (1989) Environmental Impact Statement - Woodbridge and Melton: Proposed Flood Defence Improvements. NRA, Anglian Region.

National Rivers Authority (1990) Environmental Statement - Colne Brook Regrading. NRA Thames Region.

National Rivers Authority (1991) Report to Accompany the Planning Application for the Flood Defence Works at Church Lammas, Staines. NRA Thames Region.

National Rivers Authority (1995) Written Justification for not producing an Environmental Statement - Lower Colne Improvement Scheme: Townsmead Defences. NRA, Thames Region.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CULVERTS AND TUNNELS

## 1. Introduction

This guidance note seeks to identify potential impacts upon the water environment arising from the construction of culverts and tunnels. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) in the Environmental Assessment (EA) of projects containing such structures. It is intended to assist developers who wish to construct culverts or tunnels to identify the impacts of such development on the water environment and to minimise these through appropriate project design and good construction practice. The NRA has an interest in culverts and tunnels owing to its statutory responsibilities under the Water Resources Act 1991 for land drainage, flood defence and the protection and enhancement of the water environment.

Culverts and/or tunnels are usually designed to contain the flow of a watercourse and channel it either below, or around man-made structures. A variety of design and construction types exist, ranging from steel or concrete slabs placed at the sides of a watercourse, which may or may not be covered, to cylindrical or four-sided pipes where the stream bed is replaced. In the first instance some element of a natural watercourse is retained, the latter are examples of completely artificial water channels.

The NRA would generally oppose culverting because of the loss of natural habitat and the increased flood risk associated with such structures, as they cannot be easily enlarged once constructed. Also, the structure may conceal a watercourse and could encourage development above or near it, a situation which the NRA would strongly resist. This approach is formalised in an NRA guidance note for local planning authorities on the methods of protecting the water environment through Development Plans (NRA, 1994a), which states the culverting of watercourses will not normally be permitted by the NRA.

The NRA also advises against culverting and encourages its removal in favour the rehabilitation of natural watercourses in order to protect the amenity and habitat value of the river corridor. Proposers of culverting schemes are therefore encouraged to seek alternatives which utilise the watercourse as a feature of a development and enhance the surrounding area. Where this is not possible, any culverting proposal must be shown to be environmentally and hydraulically acceptable.

Where a developer wishes to construct a culvert the NRA must be satisfied that the proposals:
- Should not cause flooding either at the site, or upstream and downstream of the site;
- Should not prevent the solution of existing flooding problems;
- Should not prevent maintenance of the watercourse.

The NRA will provide advice to developers regarding suitable design criteria for culverts and tunnels. A technical manual provides detailed specifications (NRA, 1994b).

## 2. Development control

Where culverts or tunnels form part of a larger development proposal, such as a road, car park, building or other change of land use, their construction will require local authority planning consent under the Town and Country Planning Act 1990 (as amended). Even where a culvert or tunnel is not part of a larger development, such work may nevertheless constitute development as an engineering or other operation for which planning permission is required. For example, development consent is required for revetment works that are constructed within a main river.

The NRA is a statutory consultee under the Town and Country Planning (General Development Order) 1988 (SI Nº 1813; NRA substituted by SI 1989 Nº 1590) for development involving works or operations in the bed of, or on the banks of a river or stream.

## 3. Environmental Assessment

The construction of culverts or tunnels are not specified as requiring EA under the 1988 Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199). However, where such works are an integral part of a larger development that falls under these Regulations, the impact of any culverting should be addressed in an EA of the development proposal. In such cases the conduct of an EA and subsequent preparation of an Environmental Statement should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

Where proposed culverting does not require a formal EA as part of a larger development, it may nevertheless be worthwhile to undertake some form of assessment. The NRA, as consenting authority for land drainage (see next section), may request environmental information concerning a specific development in order to determine an application for Land Drainage Consent. Such information may be required in order for the NRA to discharge its statutory responsibilities for land drainage, flood defence, fisheries and conservation and enhancement of the water environment. An EA may provide the most appropriate method for collating relevant information.

## 4. NRA consents

Culverting of a watercourse will require consent from the NRA under either Section 109 of the Water Resources Act 1991, where the watercourse is classified as a Main River, or under Section 23 of the Land Drainage Act 1991, where it is classified as an 'ordinary' watercourse.

## 5. Major potential impacts

The significance of culverting impacts upon the water environment are likely to vary with local geomorphological, hydrological and ecological conditions. In some instances, flood control may be the primary concern of the NRA, whereas in others it may be the conservation and enhancement of the aquatic environment. This guidance does not discriminate between such issues and it would be for an EA to determine the relevant issues relating to the preposed culverting of a specific watercourse.

## 5.1 Construction

Construction of a culvert or tunnel will usually involve dredging and bank reinforcement. The potential impacts of these activities are dealt with in other guidance notes of this series, which developers should consult. These are guidance note No. 1 (General Construction), No. 31 (Channel Works, including fluvial dredging) and No. 32 (Bank Protection).

The most significant construction impacts of likely concern to the NRA include:
- Destruction of river bed and riparian habitat.
- Increased turbidity from dredging, with associated downstream siltation.
- Disturbance of fish movement and fish spawning areas.

## 5.2 End state

Culverting can affect many aspects of the water environment, including river morphology, hydrology, flood defence, wildlife and fisheries and human activities related to the water environment. Potential impacts are presented below under these headings.

**River morphology/hydrology**
- Interference with routine maintenance of a watercourse.
- Loss of pool/riffle sequence and possible channel bed adjustment up and downstream.
- Narrowing of channel and alteration of natural bed slope.
- Decrease in water turbulence that could reduce oxygenation of water.
- 'Waterfall' effect at the lower lip of a culvert and increased bed erosion downstream as a result of higher water velocity.
- Increased bank erosion downstream.
- Restriction of riparian drainage.

**Flood defence**
- Loss of floodplain storage capacity.
- Constriction of flow within a watercourse which may increase the likelihood and/or intensity of flood.
- Increased potential for flow blockage and subsequent flooding, particularly where trash screens are used.
- Should blockage of a culvert occur, this cannot be removed during floods and may be a hazardous task for personnel after a flood.
- Possible future exceedence of the design limit of the structure with consequent flooding.

**Wildlife**
- Interruption of the continuity of river a corridor. This may lead to isolation of habitats with possible consequent reduction of species numbers and diversity.
- Increased water velocity within a culvert or tunnel could act as a barrier to the upstream migration of wildlife.
- Loss of light within an enclosed culvert or tunnel would inhibit plant life.
- A culvert or tunnel may act as a barrier to mammals. Otters, for example, often avoid culverts and detour around them, only to be injured upon crossing roads.

**Fisheries**

- Increased water velocity within a culvert or tunnel could act as a barrier to upstream movement of fish, including migration of salmonids. This may prevent normal fish spawning upstream.
- Culverting may result in a loss of access to water for anglers.

**Human beings**

- Construction of a culvert is likely to cause loss of visual amenity and be detrimental to the character of a river landscape.
- Loss of access to riparian and aquatic habitats.
- Restriction of riparian and water-based recreation opportunities such as angling and boating.

## 6. Mitigation measures

Where culverting is seen as the only available option the NRA would wish to see relevant impact mitigation measures, such as those listed below, incorporated into a proposal, in addition to any design criteria specified by Development Control Officers:

- Culverting must be restricted to the minimum practicable length of watercourse as the severity of impact of these constructions increases with their length.
- Culverts should be inserted below existing river bed level to allow for bed formation within the culvert.
- Where low rivers flows are likely to occur, a culvert should incorporate a low-flow channel within its base to retain sufficient water depth for aquatic life at such times.
- Watercourses should not be deepened or widened up or downstream of culverts.
- Artificial bank reinforcement should be avoided if possible. Where it is absolutely necessary, "soft" engineering techniques should be used (see Guidance note 32).
- Where "hard" engineering structures such as concrete revetments are constructed, they should be kept to a minimum, screened with willows and/or reeds where practicable and/or covered with soil and seeded.
- Artificial lining of new ditches, for example at the side of roads, should be avoided wherever possible.
- Culverts should be wide enough to allow for ledges approximately 500mm wide and 300mm above normal water level for the passage of mammals. These should link to the banks up and downstream of the culvert.
- Baffles providing shelter for fish as they pass upstream through the culvert may be incorporated into the design of a culvert base.
- The NRA encourages the provision of holes and ledges in culverts for use as nesting sites and also of bat and bird boxes within the riparian area.
- Construction works should be carried out during a suitable time of year so as not to disturb fish spawning or bird nesting seasons.
- Disturbance to riparian habitats during construction should be minimised. Mature trees should be left intact where possible.
- Any lost aquatic or riparian habitat should be replaced if this is practicable. The creation of marginal or wetland habitats adjacent to development is encouraged.

## 7. Baseline surveys

Baseline studies should include a river corridor survey (NRA, 1992) up and downstream of the development site. A habitat survey would also be necessary, where particular attention should be paid to species of flora and fauna that may become isolated as a result of culverting a watercourse. A geomorphological survey of that river up and downstream of the proposed development should also be undertaken to assess the stability of a watercourse in terms of erosion and deposition.

## 8. Monitoring

On-site supervision of working practice by an environmental specialist should be arranged, particularly if sensitive habitats or species are present.

An appropriate monitoring strategy should be developed to assess the impacts of a culvert. Changes in river morphology and sediment distribution after completion of the project should be recorded for several years. Establishment of new vegetation around the development should be monitored, as should the effectiveness of mitigation measures to encourage bats and birds, and minimise impacts upon mammals.

## 9. References and guidance

Brookes, A. (1988) *Channelized Rivers: Perspectives for Environmental Management.* John Wiley & Sons Ltd.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

National Rivers Authority (1992) *River Corridor Surveys: Methods and Procedures.* Conservation Technical Handbook No. 1, NRA, Bristol.

National Rivers Authority (1994a) *Guidance notes for Local Planning Authorities on the methods of protecting the water environment through Development Plans.* NRA, Bristol.

National Rivers Authority (1994b) *Flood Defence Technical Liaison Manual: Guidelines for Land Drainage Consenting & Planning Liaison.* NRA, Severn-Trent Region.

Royal Society for Protection of Birds, National Rivers Authority & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

### Pollution Prevention Guidelines

- Pollution Prevention Guidelines 1: *General Guide to the Prevention of Pollution of Controlled Waters.* NRA, Bristol.

- Pollution Prevention Guidelines 5: *Works in, Near or Liable to Affect Watercourses.* NRA, Bristol.

- Pollution Prevention Guidelines 6: *Working at Demolition or Construction Sites.* NRA, Bristol.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF BARRIERS/BRIDGES/WEIRS

## 1. Introduction

This guidance note seeks to identify the potential impact on the water environment of barriers, bridges and weirs. It is designed to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such projects. It will be relevant to private developers, local authority highway departments, the Highways Agency and drainage authorities. The NRA has an interest in barriers, bridges and weirs owing to its statutory responsibilities for flood defence and the protection and enhancement of the water environment.

Weirs and/or sluices are often used to control river flow or water levels, measure flow, reduce the gradient of an erosive river or for amenity, conservation or fisheries reasons. They may also be used in the generation of hydropower and for the restoration of unstable river channels (Sheilds *et al* 1994). The rationale for any particular scheme will affect its design. As a weir acts as an obstruction to water flow, they are not suited to moderate or fast-flowing rivers and the NRA would usually object to their construction in such situations unless some over-riding benefit was demonstrated.

Bridges may also interfere with the flow of a watercourse where instream span supports are required. This guidance note is intended to identify issues of concern to the NRA regarding all types of in-channel structure that may restrict water flow.

## 2. Development control

Bridges included as part of a proposed local authority highway development fall under the Town and Country Planning system and will therefore require consent from a local planning authority. Bridges associated with highways and trunk roads promoted by the Highways Agency or Welsh Office do not go through the local planning process but are subject to public consultation, draft orders and Public Enquiry. The Transport and Works Act 1992 may also be used. This will be relevant to major infrastructure projects which would previously have required a Parliamentary 'Private Bill'.

Whilst small-scale structures such as some sluices and weirs that lie entirely within a watercourse are unlikely to require development consent, any construction obstructing water flow which also forms part of a larger development proposal, such as a recreational facility, will require local authority planning permission will.

The NRA is a statutory consultee under the Town and Country Planning (General Development Order) 1988 (SI Nº 1813; NRA substituted by SI 1989 Nº 1590) for developments involving works or operations in the bed of, or on the banks of a river or stream.

## 3. Environmental Assessment

New weirs, sluices and flow control structures or alterations to these structures fall within the definition of 'drainage improvement' and are therefore subject to the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1217). These Regulations were amended slightly by Regulations (SI 1995 Nº 2195). The Regulations impose a procedural requirement on all drainage bodies that must be followed when they propose to conduct any drainage improvement works. This procedure specifies that an environmental assessment (EA) must be conducted where the proposed works are likely to have significant effects on the environment by reason of their nature, size or location. It is for the drainage authority to determine if an EA is warranted. The drainage body must give notice in the local press of any land drainage improvement works, with a statement as to whether or not an EA will be carried out for the proposed project.

Bridges which do not form an integral part of flood alleviation schemes fall outside the definition of 'drainage improvement' are not subject to SI 1217. However, if a bridge over a watercourse is part of a new road development undertaken by a local authority or private developer, its construction may fall within remit of the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199). Such roads are identified in these Regulations as Schedule 2 projects that will require EA if they are likely to have significant effects on the environment. The planning authority must determine if an EA is required.

Where a bridge over water is part of a trunk road or motorway over 10km in length, or over 1 km where the route passes through a sensitive area, an EA of the whole scheme must be undertaken under the Highways (Assessment of Environmental Effects) Regulations 1988 (SI 1988 Nº 1241).

The conduct of an EA and subsequent preparation of an Environmental Statement should follow the guidelines prepared by the Department of the Environment (DoE, 1995). In EAs undertaken by Highways Authorities are generally prepared in accordance with the Design Manual for Roads and Bridges, Volume 11 (Department of Transport 1993).

Even where a formal EA is not required by the above Regulations for any bridge, weir, sluice or other structure that may impede river flow, it may nevertheless be appropriate that some form of EA is undertaken. The NRA, as consenting authority for such works under the 1991 Water Resources Act, may request that environmental and other information be provided in order to determine an application. Any such request will be in relation to its statutory obligations for flood defence and protection of the water environment. In addition, the NRA has a duty under the 1991 Act to further the conservation and enhancement of natural beauty in respect of proposals relating to its functions, including its regulatory activities. An EA may provide the most appropriate method by which a developer may collate relevant environmental information.

## 4. NRA consents/licences

With respect to weirs, sluices and similar obstructions to flow, NRA Consent will be required under Section 109 of the Land Drainage Act 1991 for the erection of any structure in, over or under a watercourse.

The construction, removal or modification of any weir or impounding structure may also require an Impounding Licence from the NRA.

Any person intending to construct a bridge over a watercourse requires Consent or prior approval of the NRA. In the case of a bridge over a main river, Consent is required under Section 109 of the 1991 Water Resources Act. Bridges over 'ordinary' watercourses require Land Drainage Consent under Section 23 of the 1991 Land Drainage Act where the structure interferes with river flow.

Under Section 339 of the Highways Act 1980, a Highway Authority may not interfere with any watercourse, including its banks, without Consent from the NRA. However, bridges for road schemes carried out by Highway Authorities by virtue of Orders made in accordance with Schedule 1 of the Highways Act 1980 may not require Land Drainage Consent. Detailed guidance will be issued by the NRA in the near future regarding Land Drainage Consent requirements of road bridges over navigable/non-navigable rivers and main/ordinary watercourses.

## 5. Major potential impacts

The main potential impacts of barriers to flow upon the water environment are due to the alteration of flow regime and geomorphology of a watercourse and associated destruction or disturbance of aquatic and/or riparian habitat. This guidance note does not examine the potential impacts of various individual types of development, but rather describes the generic impacts associated with such structures.

The construction of bridges, weirs and sluices will exert an immediate and direct impact on the water environment by virtue of the probable destruction of aquatic, riparian and terrestrial habitats resulting from construction activities. These issues are not dealt with here as potential impacts arising from construction activities are explained in another guidance note of this series: Guidance Note 1. (General Construction).

### 5.1 Hydrology

Upstream of any impediment to flow, water velocity will be reduced and water depth may increase. Downstream of such a structure, water velocity is likely to increase and water flow become turbulent.

Increased water depth upstream of any flow constriction may result in an increased risk of flood and also enhance the magnitude, frequency and duration of any flood event. Marginal or riparian areas may become permanently or periodically inundated and riparian drainage is likely to be inhibited. These impacts are most likely to be seen upstream of an impounding structure such as a weir or sluice, but may also occur to some extent where bridge supports or any other structure acts to constrict river flow.

## 5.2 Geomorphology

Reduction of flow velocity upstream of any constriction is likely to create a depositing environment within a channel which may further increase the risk of flood. In turn, such deposition may lead to a change in river bed slope with subsequent upstream channel adjustment and disturbance to the riffle/pool structure.

Downstream of a weir, sluice or bridge increased flow velocity and turbulence is likely to cause increased erosion of both river bed and banks. Such erosion may be very forceful immediately downstream of any constriction, as for example below the lip of a weir, although the intensity of this impact will depend on the type of structure involved. Material carried in suspension will be deposited further downstream and may alter the sediment profile of a channel for some considerable distance.

In the event of collapse of an unmaintained weir or sluice, channel banks may disintegrate and accumulated sediments be washed downstream.

## 5.3 Water quality

Where water is impounded by any impediment to flow, its oxygenation by gaseous exchange is likely to be reduced as the water volume/surface area ratio is changed. This may be exacerbated by the deposition and subsequent decomposition of organic material that will exert an oxygen demand. Growth of macrophytes and algae in static waters upstream of a structure may reduce the oxygen content of the water.

Downstream of a flow constriction, although increased turbulence may assist oxygenation of water, suspended solids arising from channel bed and bank erosion are likely to increase water turbidity.

## 5.4 Aquatic ecology

An increased water depth, reduction of water velocity and creation of a depositing environment upstream of a barrier, bridge or weir is likely to exert a considerable impact on the existing aquatic flora and fauna (Armitage & Pardo, 1995; Walker *et al*, 1994). Plant, invertebrate and fish species sensitive to any of these changes are likely to be lost and may be replaced by other species more suited to lower flow velocities. A depositional environment may lead to a reduction in ecological diversity and loss of fish spawning gravels and as the river bed is smothered. An increased depth of water may submerge existing bankside areas with a consequent loss of marginal flora and associated breeding and feeding sites for insects, amphibians, mammals and wildfowl. The impoundment immediately above any obstruction to flow would comprise a different habitat to the usual flowing water environment and could cause disruption within the habitat continuum of a watercourse. Such impoundments may also suffer from problems with invasive species, which may then migrate downstream.

Immediately downstream of an obstruction to flow, erosion of river bed and banks is likely to cause changes in the aquatic community. Some areas of river bed and bank may be rendered unsuitable for the aquatic life previously present and will become colonised by species adapted to fast, turbulent water. After a time, erosion below a structure is likely to create a deep pool and new fauna and flora may come to colonise this.

Bridges increase the shading of a watercourse and this may lead to the elimination of bankside and aquatic flora in the immediate vicinity. The reinforcement or loss of natural riverbanks are usually associated with bridge construction and this must lead to destruction of aquatic and marginal habitat.

The physical structure of a weir, sluice or bridge may act as a barrier to fish migration and could cause a change in fish behaviour. Weirs may completely obstruct the spawning migrations of salmonids, and also of non-salmonid fish such as chub and barbel. They may also seriously impede the upstream spread of young eels in a river system. Similarly, any weir, sluice or bridge may inhibit the movement of aquatic mammals along a river corridor.

When a weir is drained for desilting, this may cause a severe reduction in fish and invertebrate populations downstream (Doeg & Koehn, 1994)

### 5.5 Terrestrial ecology

Bridges and to a lesser extent, weirs and sluices, are likely to result in a complete loss of some riparian habitat by virtue of the use of land adjacent to a watercourse for their development.

Impoundment of water upstream of an obstruction to flow may cause inundation of terrestrial and riparian habitats. Wetlands are likely to undergo substantial re-adjustment to a new flow regime and may take many years to stabilise. Where riparian areas become waterlogged or suffer impeded drainage the existing vegetation is likely to change, with death of mature trees, shrubs and flowers accustomed to drier soils.

### 5.6 Human related impacts

Any structure that acts to restrict water flow is likely to cause disruption to commercial and recreational navigation. Any alteration of river depth or velocity above and below an obstruction may change angling quality. Impoundment of water behind a weir or sluice may cause an adverse visual impact if rubbish/trash is allowed to collect and may also cause an offensive odour if the water becomes stagnant.

The physical appearance of a bridge, weir, sluice or suchlike may have an adverse visual impact on the natural river landscape. Such structures are also likely to cause some loss of riparian land.

The noise impact of cascading water resulting from the construction of a weir should be assessed in the context of the surrounding area.

## 6. Mitigation measures

Mitigation measures for bridges, weirs and sluices should attempt to reduce or avoid excessive channel erosion below an obstruction to flow and to mitigate impacts of impoundment above this. Such measures must strive to maintain the continuity of aquatic and terrestrial habitats along the river corridor wherever possible. In some situations the creation of a new water impoundment above an obstruction and formation of an eroded pool below it can be used to enhance the recreational or amenity value of a watercourse and to provide new marginal habitats that may benefit wildlife such as birds.

Suggested measures for mitigation and enhancement are provided below for all structures that may inhibit flow with additional specific suggestions for weirs, sluices and bridges. The *New Rivers and Wildlife Handbook* (RSPB *et al*, 1994) is recommended as a central reference for appropriate mitigation and enhancements.

- Any new structure that constricts or obstructs river flow must allow the passage of all fish, both up and downstream.
- Shallow-water margins should be created in any water impoundment to encourage wetland habitat formation.
- Downstream of a flow impediment, bays and other sheltered water features should be excavated to provide shelter for small fish, amphibians and mature fish in times of flood.
- Existing riparian vegetation, especially trees, should be conserved where possible.
- Consideration should be given to the establishment of turbulent pool and riffle features immediately downstream of any structure that inhibits river flow.

**Weirs**

- Adequate protection against backward scour erosion should be provided immediately downstream of a weir to prevent undermining of the structure.
- A weir crest should aim to provide an attractive visual impact. An irregular cascade over a flat slope is to be preferred.
- A weir basin may be designed to dissipate hydraulic energy to prevent downstream pool scouring. Where formation of a large pool is desired for recreation, aesthetics or habitat enhancement this basin may be eliminated.
- Although the crest of a weir should be horizontal across its full width, shallow variations are desirable to concentrate low flows.
- Weirs should be designed to allow and facilitate the upstream and downstream movement of all fish, with fish ladders provided if necessary.
- Initial excavation of a pool below a weir may be used to assist habitat enhancement and prevent downstream transportation of eroded material.
- A weir management program should be formulated to accompany any development proposal. This must state arrangements for adjustment of water levels and a proposed desilting schedule.

**Sluices**

- Sluices should be designed to minimise loss of fish (to irrigation channels for example) in times of flood. Screening may be required in some circumstances.

**Bridges**

- Clear span bridges should be provided where possible.
- Where a clear span bridge is not feasible a ledge, either in the form of a concrete shelf or gravel side bar, or mammal tunnels should be provided.
- Open parapets should be used to allow some over-deck flow in the event of the bridge opening becoming blocked in a major flood event.

- Bridge soffit levels and flood spans should be at least 1 metre above maximum known flood level to allow floating debris to pass freely through the structure.
- Where the substratum of a watercourse is disturbed by bridge construction, this should be replaced. Gravel is most often used.
- Consideration should be given to the provision of features within bridge design to encourage nesting of birds and bats.

## 7. Baseline surveys

A geomorphological survey of river structure should be undertaken in the vicinity of a proposed development to assess the stability of a watercourse in terms of erosion and deposition. A comprehensive survey of habitats, flora and fauna will also be necessary baseline information for an EA. This should take the form of a river corridor survey (NRA, 1992) incorporating a detailed habitat survey of the aquatic, marginal, bank and floodplain zones.

A fish survey may be desirable where a proposed development is within a river or reach that possesses a high fisheries value, and in certain situations baseline information concerning water-based recreational activities may also be appropriate.

## 8. Monitoring

An appropriate monitoring strategy should be developed to assess the impacts of a bridge, weir or other barrier to flow. Changes in river morphology and sediment distribution after completion of the project should be recorded for several years. Establishment of new vegetation around the new water level should be monitored, as should the effectiveness of mitigation measures.

## 9. References and guidance

Armitage, P.D. & Pardo, I (1995) Impact assessment of regulation at the reach level using macroinvertebrate information from mesohabitats. *Regulated Rivers: Research and Management* 10: 147-158.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide*. HMSO, London.

Department of Transport (1993) *Design Manual for Roads and Bridges, Volume 11*. Department of Transport, London.

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Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

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**Pollution Prevention Guidelines**

- Pollution Prevention Guidelines 1: *General Guide to the Prevention of Pollution of Controlled Waters.* NRA, Bristol.

- Pollution Prevention Guidelines 5: *Works in, Near or Liable to Affect Watercourses.* NRA, Bristol.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF OFF-LINE PONDS AND RESERVOIRS

See Guidance Note 2

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF COASTAL PROTECTION PROJECTS

### 1. Introduction

This guidance note seeks to identify the potential environmental impacts of coastal protection schemes. It is intended to act as a scoping brief to assist any appropriate authority or landowner in environmental impact studies of such projects. In this guidance note 'coastal protection' refers to the defence of low-lying land against flooding by the sea or tidal water. This is also referred to as sea defence or coastal defence. This guidance note does not deal with protection of the land surface against erosion and encroachment by the sea, as that falls under local authority control as detailed within the Coast Protection Act 1949. The National Rivers Authority (NRA) has an interest in coastal defence because of its statutory operational responsibilities for sea and tidal defence as defined within the 1991 Water Resources Act (WRA).

Overall policy decisions for coastal defence are the responsibility of the Ministry of Agriculture, Fisheries and Food (MAFF) in England, and the Welsh Office (WO) in Wales. Operational responsibility for the planning, design, construction and maintenance of sea defences lie primarily with the regional offices of the NRA. In areas of special drainage needs, such as the Norfolk Broadland and the Somerset Levels, works are administered by Internal Drainage Boards (IDB's). Local authorities are responsible for flood defence measures in areas not covered by either the NRA or IDB's. Local authorities and IDB's have powers under the Land Drainage Act 1991 (LDA).

In addition to the above, the Crown Estate, Property Service Agency and various dock, port, harbour and navigation authorities also possess statutory powers in relation to sea defence within their areas. Landowners with a coastal frontage may provide their own flood defences. The WRA provides the NRA with a general duty of supervision over all sea defences and it can act in default of other authorities.

The WRA and LDA require that in carrying out their functions with respect to coastal defence the NRA and IDB's:

- Further the conservation and enhancement of natural beauty.
- Further the conservation of wildlife and geographical and geomorphological features of special interest.
- Have regard to the desirability of
    - protecting and conserving buildings, sites and objects of archaeological, architectural or historic interest; and
    - preserving public rights of access to areas of mountains, moor, heath, down, cliff or foreshore and other places of natural beauty.
- Take into account the effect of any proposals on the preservation of rights of access and on the beauty or amenity of an area, or on wildlife, features, buildings, sites or objects.

Satisfactory defences against inundation by the sea cannot be planned or constructed in isolation. Effective liaison is necessary between local authorities, the NRA, IDB's and other interested parties (NRA, 1993a). Such liaison is vital in the preparation of Coastal, Shoreline and Estuary Management Plans, which together provide a structure within the strategic framework of statutory development plans to address the need for sea and tidal defences and related issues such as development control, landscape management, access for recreation etc. The strategic aspects of planning and flood risk, including sea defence, are examined in *Planning and Flood Risk: A Strategic Approach for the NRA* (NRA, 1993b).

In broad terms most coastal defence schemes fall into two main categories:
- Those, like traditional sea defences, that are designed to resist or deform natural coastal processes are classified as 'hard' engineering. These may take the form of sea walls, banks, revetments and tidal surge barriers.
- Those that seek to emulate or enhance natural coastal processes are referred to as 'soft' engineering options. These include beach nourishment and dune building.

Another management option for sea defence is that of 'managed retreat', where the line of sea defence is moved inland, effectively forming a new inter-tidal area. As such schemes do not comprise erection of alternative defence structures to those identified above but rather an alternative location for them, the potential impacts associated with managed retreat are examined only briefly in this guidance note.

The environmental impacts of tidal surge barriers are not examined here as they are dealt with in Guidance Note No.4 of this series (Barrages).

It is national policy that a range of options should be considered as part of project appraisal. Coastal defence schemes should be sustainable, based on an understanding of natural processes and, as far as possible, work with those processes (MAFF & WO, 1993). These include short-term natural processes such as storm surges, surface wind, geomorphological change, waves and tide, and long-term processes such as geological crustal movement, global/regional climate change and relative sea level change caused by these. In addition, human impacts and influences such as settlement/development in coastal areas, change in surface water run-off and alteration of natural coastal processes must also be considered in the planning and design of sea defences.

Any evaluation of alternative options for sea defences should assess the environmental costs and benefits of each. Some form of Environmental Assessment (EA) should be used in both the strategic planning of sea defences and in the design process of individual schemes. Several guidelines are available from MAFF covering the environmental aspects of sea defence planning and project appraisal (MAFF, 1993a, b, c).

## 2. Development control

New coastal flood defence schemes are subject to normal control by local planning authorities under the Town and Country Planning Act 1990 (as amended) and will require development consent. Prior approval from MAFF/WO is required for all coastal defence schemes submitted by local authorities. Grant aid is available from MAFF/WO for coastal defence projects and it is a precondition of such aid that developments are technically, environmentally and economically sound.

Improvement to existing sea defence works undertaken by the NRA and other drainage bodies are classified as permitted development under the Town and Country Planning (General Development) Order (SI 1995, Nº 418) and are granted deemed planning consent, although they are covered by EA procedures (see below). Control over such permitted development lies with MAFF/WO and is usually implemented through the provision of grant aid.

Operations involving the deposit of materials below mean high water mark require a licence under the Food and Environment Protection Act 1985. This procedure is administered by MAFF and in considering whether to grant a licence the Ministry is required to have regard to the possible impact of any deposit on the marine environment.

### 3. Environmental Assessment

Flood defence works and defences against the sea are subject to either the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1199) or the Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1217). The former is applicable to developments undertaken privately or by local authorities, and the latter to permitted developments undertaken by drainage authorities. Flood defence capital works are identified in Schedule 2 of these Regulations. As such, EA of a coastal defence development may be required if the project is likely to have a significant effect on the environment by virtue of its nature, size or location. It is for the local planning authority to determine if an EA is required under SI 1199 and for the drainage authority acting as developer under SI 1217.

The exploitation of mineral resources is identified in Annex II of the EA Directive (CEC, 1985). The requirements of this Directive were incorporated into the Government View Procedure in 1989. As such, an EA of proposed dredging activities for beach nourishment or dune building may be required in an application to the Crown Estate for a mineral extraction licence. An EA may be necessary if these activities are deemed likely to have a significant effect on the environment by virtue of their nature, size or location. The decision as to whether an EA should be conducted lies with the co-ordinating Government Department (usually the DoE or WO).

Where a formal EA of sea defence works is not required by a planning authority or any other authority, it is nevertheless good practice for an IDB, Maritime District Authority or private developer to conduct some form of EA for any project. The NRA will always carry out EA to an appropriate level for all projects and programmes to ensure that its operations concerned with sea defence are carried out in accordance with its statutory duties regarding environmental protection. Where prior approval or grant aid is sought from MAFF/WO, an EA may provide the most appropriate means for an authority or private developer to demonstrate that a proposed coastal defence scheme is environmentally sound.

The conduct of an EA and subsequent preparation of an Environmental Statement or informal report should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents/licences

No NRA licences or consents are applicable to coastal defence developments, although in practice close liaison is maintained with Maritime District Councils as it is recognised that such works cannot be constructed in isolation.

## 5. Major potential impacts

Each coastal defence scheme is likely to be unique in terms of its engineering details and environmental conditions. Similar engineering methods may therefore not impact the same environmental parameters in different situations. It has been clearly demonstrated that EA of coastal defence projects benefits from discussion with the local community, nature conservation groups and other interest groups, in addition to contact with statutory consultees. Consultation should always be undertaken at an early stage in project planning so that impacts identified at this stage may be addressed by selecting appropriate options and appropriate project design.

The siting and nature of sea defence projects raises the possibility that they may impact upon designated sites that are afforded some degree of statutory protection. These may be international designations such as World Heritage Site, Biosphere Reserve, Ramsar Site, Special Protection Area or Special Area of Conservation that imply a high degree of protection. Other statutory designations include those of National Park, National Nature Reserve, Marine Nature Reserve, Site of Special Scientific Interest, Area of Outstanding Natural Beauty and scheduled Ancient Monument. Non-statutory designations do not possess such a high level of protection but are likely to have local importance. These include Heritage Coast, Local Nature Reserve, Wildlife Trust Reserve, County Site of Conservation or Geological Importance, Historic Landscape Area and Area of Archaeological Interest. In all cases where the proposed works are within or adjacent to such sites, the relevant statutory or other bodies should be consulted on their views concerning the potential impacts of any works upon the designated area.

This guidance note examines the potential environmental impacts of hard and soft engineering schemes separately, as the issues involved with either option are different. Potential impacts are described for both the construction and end-state phases of these types of sea defences.

### 5.1 Hard engineering projects

Proposed developments to prevent inundation by the sea usually involve the erection of some form of permanent barrier structure. These may be relatively simple constructions, such as an earthen embankment on shore, that require little preliminary groundwork. Alternatively, engineering criteria may demand a complex seawall construction with comprehensive structural foundations. This guidance note does not discriminate between different types of project but seeks to highlight by example, broad classes of environmental impact common to hard engineering schemes.

### 5.1.1 Construction

The construction of a sea wall or any other structure designed to prevent flooding of land will usually involve extensive site preparation, excavation and/or transport of materials such as earth, rock, concrete or cement.

**Human beings**
Construction activities may cause nuisance to local residents as levels of traffic congestion, noise, dust and vibration increase. Works could also disrupt road or footpath access to the sea for the purpose of general amenity or recreation. During construction, stockpiles of materials and contractors equipment may cause a detrimental visual impact to the landscape. These impacts could be of particular significance in a locality visited by tourists. Where the intensity of construction impacts such as noise, traffic congestion, loss of visual amenity or restricted access to the coast are considerable, this may have an adverse economic impact on any community that is largely dependent on tourism.

Where barrier structures are raised as new developments they may encroach on features of scenic or archaeological interest and there may be some impact on local farmers as construction works adjacent to their land could disrupt normal agricultural activity.

**Water quality**
Where dredging operations are undertaken during construction work, suspended material may result in a short-term increase in water turbidity and cause organic pollution. Fine sediments also act as a sink for many pollutants introduced into the marine environment and dredging operations could result in re-suspension of these contaminants. This may be a particular cause for concern at sites adjacent to existing or former sewage or industrial effluent outfalls. The consequent chemical pollution of coastal waters could be severe. The discharge of water from de-watering operations associated with dredging could also pollute controlled waters.

Large-scale excavation or storage of soil on land may impact on water quality if rainwater is able to wash sediments into surface or marine waters. Such material could temporarily increase suspended solids and water turbidity and cause organic pollution.

The use of construction materials such as cement and oil/fuel for machinery close to controlled waters will pose a risk of pollution from site runoff and accidental spillages etc.

**Wildlife**
Construction activities on land may cause direct destruction of terrestrial habitats and flora. This may include the loss of mature trees or other vegetation that act as breeding or feeding sites for wildlife, including bird populations, which are often regarded as a significant wildlife resource in coastal areas. Some areas of vegetation and topsoil may need to be cleared altogether and even where topsoil is replaced, the original vegetation may not re-establish itself for some time.

Where construction activity is below high water mark, littoral or marine flora and fauna may suffer disruption or destruction of their natural habitat. Even where construction works are above this level, leachates from fill material or spillages from construction plant may impact upon wildlife beyond the immediate vicinity of a construction site. Such impacts may be particularly significant where fish or shellfish are taken locally for human consumption.

Where dredging operations are conducted during construction work, increased water turbidity may attenuate penetration of sunlight into the sea around the dredging site, thus reducing photosynthesis of plants and algae.

### 5.1.2 End state

**Human beings**
In the long-term, a hard sea defence scheme will have a beneficial impact upon human beings and material assets by protecting them from inundation by the sea. This may also benefit agricultural land previously under threat.

A hard structure built to protect against flood is likely to inhibit human access to the sea or coast in its vicinity. Water-based or land-based recreation opportunities within the coastal zone immediately adjacent to the defences may be permanently restricted

**Geomorphology**
A new hard sea defence structure may alter natural coastal processes in its immediate vicinity and along adjacent lengths of unprotected coastline. Seawalls or revetments that, in effect, increase shore slope could exert a detrimental impact on the beach or estuarine mudflat which front them, by increasing wave reflection, under-tow currents and scour. This could result in increased erosion in the front of a new structure and possible gravel/sand/mud deposition further along the coast. Alternatively, in some situations new hard sea defences can encourage deposition of material on the beach in front by lowering the existing shore profile. This may, in turn, reduce the intensity of wave-breaking, backwash or tide/scour patterns and increase deposition. It has often been the case that unforeseen material erosion or deposition has occurred after the construction of traditional coastal defence structures and led to a reduction in their life expectancy (Countryside Commission, 1993).

**Hydrology**
Surface water and sub-surface drainage from low-lying land immediately behind a sea defence structure could be impaired. This may comprise either a beneficial or adverse impact, depending on existing land use. Where land is used for agriculture, waterlogged soils could adversely affect farming activity. However protection from periodic inundation by the sea, would comprise a beneficial impact. Where the land consists of natural habitat, such as salt marsh, estuarine reedbeds, bog etc., the impact may be positive or negative, depending on whether the existing habitat could exist in freshwater wetland conditions. In situations where impaired drainage is likely to occur behind hard sea defence structures, this may provide a good opportunity for creation of new wetland habitats.

**Wildlife**
Plant or animal habitat within the development boundaries of any coastal defence structure are likely to be lost or periodically disrupted by maintenance activities. Coastal or estuarine habitats adjacent to the structure, such as shingle, beach, sand dunes, salt marsh etc., may undergo changes as a result of altered erosion/deposition patterns on the foreshore or inhibition of land drainage.

New hard sea defences should benefit natural terrestrial or semi-terrestrial habitats previously under threat from inundation by the sea.

**Landscape**
There is likely to be a permanent loss of existing landscape character and visual amenity as a result of new sea defence constructions such as embankments, sea walls etc. This may be particularly significant in an area of scenic beauty, whether designated or not.

## 5.2 Soft engineering projects

Projects such as artificial beach nourishment or dune building have three key elements: that of borrowing material offshore (or occasionally inshore) by dredging, transportation to a discharge location (usually by hopper and pumped pipeline), and spreading of material in the desired location. The intention of beach nourishment or dune building is to maintain or extend the beach profile, therefore dissipating wave energy. Dunes also offer a physical barrier to the sea in storm conditions.

In sea defence terms, dunes are a sediment sink which can be eroded during storm events. In addition to the restoration of degraded dunes, dune development is often undertaken as a form of sea defence. This often requires protection from wind erosion. Available methods include vegetation planting (most commonly marram grass) and erection of brushwood or geotextile fences to act as wind-breaks.

The need for beach replenishment may arise from undercutting of a sea wall or a loss in aesthetic or recreational value when beach levels fall. Compared with other methods of coast defence, beach recharge and/or dune building is highly cost-effective and can offer potential benefits in terms of safeguarding the natural environment or the provision of improved recreation facilities.

### 5.2.1 Construction

**Human beings**
During the construction phase of pumping material ashore there may inevitably be some disruption to beach and pleasure craft users. This may be particularly significant in any locality used by tourists. Some economic loss to the local community could result from a temporary reduction in the number of visitors.

The storage, spreading and deposition of large quantities of dredged material could result in an increase in the normal level of wind-blown sand. This may cause nuisance to nearby residents and may be detrimental to adjacent agricultural land.

**Water quality**
Dredging activities are likely to increase the volume of suspended sediments and turbidity of water in the vicinity of operations. The particle size of material will influence the degree of impact.

The organic content of buried fine sediments will usually have a high biochemical oxygen demand (BOD). When such particles are suspended in the water column by dredging activities they are likely to deplete local levels of dissolved oxygen.

Dredging operations may cause re-suspension of contaminated sediments. This may be a particular cause of concern where potentially toxic material such as sewage sludge or industrial wastes have been dumped at sea in an area now licenced for mineral extraction.

Where sea bed material, contaminated with heavy metals, is pumped ashore for beach recharge or dune building and subject to rainfall and drainage, the resulting change in redox potential and pH can release the heavy metals from the sediment. This could pose a risk to the quality of inland surface or inshore coastal waters.

The storage or spreading of newly-dredged material may increase water turbidity and reduced dissolved oxygen if rainwater, wind erosion or wave action are able to transport material back into the water.

In some circumstances dredged material may be de-watered in a lagoon before being used for beach recharge or dune building. The presence of a large volume of wet material on land is likely to alter groundwater hydraulics by locally raising the water table, which may in turn impact on land drainage, soil moisture and vegetation. Excess water removed from dredged sediments may alter groundwater or surface water quality.

**Marine ecology**
Dredging is likely to destroy or disturb existing marine benthic habitats directly, through excavation or burial, or indirectly through alteration of marine currents or water quality.

Destruction of benthic fauna and flora results primarily from the direct action of a draghead and pump. Some animals and plants may remain in the cargo but most are returned to the sea as organic detritus. These will include all types of algae, small invertebrates, echinoderms, crustaceans and vertebrates. If dredging removes all of a sand overburden, the exposed strata may be of clay, rock or highly mobile sand, which have a poor recolonisation potential. In such cases the destruction of marine habitat may be considered permanent.

Where dredged sand is screened at sea and selected for size, material rejected overboard may bury marine habitats in the vicinity. Tide and wave action may further transport these particles, forming sand megaripples, ribbons and sheets, which are all largely ecologically sterile substrates (DoE, 1986). Fine sand or silt disturbed by dredging or washed overboard with hopper overflow water have the greatest potential for dispersion. Settlement of these small grains on the seabed may cause in-filling of crevices in gravel or cobbles that act as habitat for small invertebrates.

Increased turbidity caused by dredging can affect many biological processes. It may cause a decrease in algal photosynthesis and in the hunting capability of fish and marine birds. The food intake of filter-feeding zooplankton and benthic invertebrates may decrease as the ratio between edible plankton and inedible silt is disturbed (Adriaanse & Coosen, 1991). Large quantities of suspended material may also physically damage fish gills and feeding organs of other marine life.

The potential impacts on seabed ecology referred to above are likely to exert an effect on benthic productivity and the local marine food chain. These impacts are also likely to alter sea bed habitat, reduce species diversity and change invertebrate and plant biomass in an area extending outside that used for dredging, as such activity has some effect beyond the immediate area of excavation in shallow waters (CIRIA, 1991).

**Fisheries**

Fishing boats are likely to be excluded from any mineral extraction area and inshore discharge site. This, and the possible short and long term effect on fisheries of plumes of sediment and changed benthos, may comprise a significant adverse impact to a local economy.

Individual mobile shellfish such as crabs, lobster, shrimps and prawns may be destroyed directly by dredging operations. Of greater concern is the possible excavation or burial of the breeding habitat of crabs, as the female congregate to incubate their eggs. Large numbers adjacent to a dredging ground may be at risk from excavation or material deposition. Even where the females survive, disturbance of brooding behaviour may lead to abortion of eggs.

Sandeels bury themselves in the surface sands of the seabed and remain dormant throughout the winter months. They are often present in very large numbers on the seabed and are fished for use as fertiliser. Dredging for sand to be used as beach nourishment or dune building could destroy individuals, eggs and the spawning habitat of these fish.

The direct physical impacts of dredging, such as removal of bottom material and suspension of sediments, may result in the loss of fish spawning areas and change fish behaviour. For example, the behaviour of migratory fish such as salmon may be disturbed by either the noise of dredging operations or the increased water turbidity likely to prevail in the vicinity. This may result in failure to migrate to inland waters to spawn and consequent temporary local decline in the fish population.

**Terrestrial ecology**

Deposition of sand on a dune system or sand/shingle on a beach may cause the death of most terrestrial (or marine) invertebrates as few are able to move up through a thick layer of sediment.

Dune building may be directed toward the seaward side, the central dunes or the landward side. Where material is deposited in thin layers on the upper beach or central dunes, direct impacts on the existing habitat are usually minor. However, where the introduced sand is unlike that of the existing dunes and has different leaching characteristics, the natural vegetation may be disturbed for some time. Where deposition is to some considerable depth, all vegetation and habitats will be destroyed. The action of excavators and other machinery is likely to compound the extent of habitat destruction.

If dredged material is first de-watered in a lagoon before being used for beach recharge or dune building this may have adverse impacts on land use and cause loss of natural habitat, although the intensity of this impact will depend on the siting of the lagoon.

**Landscape**
The potential short-term visual impact of beach or dune nourishment may be very large. Although a loss of vegetation may not be permanent, its absence for a period of time would usually be considered detrimental to visual amenity. Similarly, a loss of dune contours, even for a short period, could be perceived as an adverse impact. Mitigation measures to reduce these effects should be addressed at the landscape planning stage of project design.

### 5.2.2 End state

In the long-term, beach or dune nourishment schemes, like hard engineering projects, will have a positive impact upon human beings and material assets by protecting them from flooding. Soft engineering options also have additional environmental advantages. The nourishment programme can be modified over time to suit prevailing conditions or perceived need and can be designed to create new habitats or to enhance existing ones. These factors should usually count as positive impacts, although an EA must examine and evaluate any proposed landscaping and re-vegetation program in detail.

**Human beings**
Periodic replenishment of dune or beach sand may cause some visual and noise intrusion to local communities.

Dune building (and associated re-vegetation) or beach nourishment could increase the recreation/amenity value of an area of coastline and are also likely to enhance the visual appeal of a landscape. These beneficial impacts would be particularly significant where the existing dune system or beach had become severely eroded.

**Terrestrial ecology**
Dune systems are recognised as having a high ecological value and the sensitive restoration or maintenance of dune habitats should be considered a major beneficial impact of this type of sea defence. Nevertheless, over-management in the past in response to the threat of dune erosion has sometimes resulted in large expanses of marram grass with little ecological diversity. The potential impact of dune building on terrestrial ecology is therefore largely dependent on the long-term management techniques employed after dune reconstruction has taken place. The greatest ecological benefits are likely to be obtained where a sympathetic and flexible vegetation management strategy is employed.

The use of earth-moving machinery to reform degraded dune ridges can cause compaction of embryo dunes and destruction of flora and bird nesting sites.

## 5.3 Managed retreat

An alternative strategy for sea defence to that of hard or soft defences situated on the coast is that of 'managed retreat', whereby the line of coastal defence is brought inland, effectively forming a new inter-tidal area. The setting back of defences may take a number of forms ranging from the preparation of a second line of defence in anticipation of the eventual failure of the first, to allowing migration of the sea inland to compensate for sea level rise (the 'do nothing' option).

Certain conditions that favour managed retreat have been identified; these are:
- that low-lying land behind any existing defence is extensively managed during and after retreat;
- the land concerned is without substantial development;
- the new inter-tidal area is backed by rising ground or a natural second line that will be easily defensible in the long term, and:
- the area of managed retreat is long in relation to its width (English Nature, 1992).

Managed retreat schemes will inevitably result in the loss of land immediately behind the present shoreline. This is likely to be agricultural land or natural/semi-natural habitat as this strategy would be inappropriate in urban or industrialised areas. While loss of land must be considered a major negative impact of managed retreat, this should be evaluated in any EA against the benefit of creating a sustainable, low cost line of sea defence. Managed retreat also provides an excellent opportunity for creating new wetland habitats, such as saltmarsh or mudflats, behind existing sea defences. A practical guide to managed retreat has been produced (English Nature, 1995).

## 6. Mitigation measures

Some mitigation measures applicable to sea defence schemes are outlined below, although the characteristics of an individual project and its situation will determine what action is taken. Project design and engineering practice should follow the Pollution Prevention Guidelines provided by the NRA (see references) and guidelines produced by MAFF (1993b) and the Construction Industry Research and Information Association (CIRIA, 1991, 1992, 1994a, b, c).

### 6.1 Hard engineering projects

- Construction traffic should be scheduled to minimise disruption of a local community and to avoid peak tourist traffic periods.
- Access to the sea by footpath or road should be maintained, by temporary routes if necessary.
- Information concerning the development should be available in public displays near the site to inform residents and visitors of the intention and schedule of construction works.
- The working area should be minimised as far as possible, in particular, the destruction of natural vegetation in sensitive areas should be avoided.
- Storage heaps of dredged or excavated material should be secure from rain or wave erosion.
- Access roads and subsidiary development activities should be located in areas of low habitat value. "Islands" of natural vegetation that would remain undisturbed should be delimited around the development site and protected by fencing as these would assist in the re-colonisation of species. Where topsoil would be temporarily removed, it should be stored and replaced.
- Impacts upon wildlife, including birds, can be reduced if works are started before the

breeding season begins, so these creatures may avoid using the development area as a nesting or breeding ground. Alternatively, construction could be limited to late summer and autumn to minimise impacts on breeding birds and wintering wildfowl.

- Where possible, hard sea defence schemes should seek to create new wildlife habitats within their construction. For example, new wetland habitats could be created to the rear of some schemes where surface and groundwater conditions allow, while new terrestrial habitats - with appropriate landscaping - could be created to the rear of other schemes. This may require land acquisition for off-site habitat enhancement and also a commitment to future maintenance.
- An appropriate landscaping scheme should be designed and implemented behind any new sea defence development. This could include vegetation or tree planting to provide habitat and shelter for wildlife.
- Where landscaping and/or habitat creation is undertaken a vegetation and general maintenance program should be designed and implemented.

## 6.2 Beach nourishment/Dune building

Both dredging and deposition of material on beaches and dunes should use the most appropriate methods that will minimise impacts, as available options have different advantages and disadvantages (Oorschot & Raalte, 1991).

### 6.2.1 Dredging

Marine dredging is inherently a destructive operation and some impacts must be accepted as an environmental cost of this form of sea defence. Nevertheless, the incorporation of mitigation measures into a dredging scheme to avoid or reduce some of the impacts described previously is possible. Some techniques for reducing impacts of mud dredging in harbours which may also be applicable to marine dredging are provided by Kirby (1994).

- The excavation of minerals should be conducted in such a way that on cessation of dredging the donor site is able to recover ecologically. This should include not excavating the whole depth of mineral strata, so recolonisation can occur, and leaving 'islands' of natural habitat within the dredging area to act as seeds for subsequent recolonisation.
- Dredging should be undertaken in pre-determined patterns, planned to minimise impact on benthic ecology and inshore fisheries.
- Screening of sand or shingle at sea and subsequent dumping overboard of unwanted grain sizes should not be undertaken unless this material is used to backfill areas previously dredged.

### 6.2.2 Onshore works

- Onshore works at any given time should be limited to a relatively short length of beach to minimise loss of amenity.
- Where beach nourishment is undertaken, the type of sand or shingle used should reflect the requirements of beach users in addition to engineering criteria. The colour and shell content of sand will be relevant.
- Sea water used for pumping extracted minerals ashore should not be abstracted from

areas likely to be contaminated with sewage effluent. Sand should be tested for contamination before access to the public is permitted.

- Periodic beach/dune maintenance nourishment should be undertaken outside of the tourist season in popular areas.
- Public information displays that explain the purpose and schedule of a nourishment program may help to offset the impacts upon human beings and generate interest in the scheme.
- The deposition of material on dunes or beaches could destroy bird nesting sites, and it is preferable that nourishment commence before the start of the breeding season.
- Efforts should be made to ensure that landscaping within dunes is harmonised with existing morphology in terms of dimensions, position and relief. This is not applicable to the seaward side where morphology is largely determined by the action of waves and tides.
- Sand stabilisation measures should be implemented immediately after dune reconstruction by planting of appropriate vegetation. Recolonisation of central and landward dunes will be assisted if the upper sand layer of existing dunes is first removed and replaced after dune nourishment. This material will contain many seeds and root stocks of the natural vegetation and also associated terrestrial invertebrates.
- Re-vegetation of dunes should use a variety of species to provide a diversity of habitats and maximise visual interest.
- Public access to dunes should be encouraged where this does not pose a threat to dune stability. The use of wooden trackways and/or fences to protect sensitive areas should be considered.
- A vegetation and general dune maintenance program should be designed and implemented.

## 7. Baseline surveys

Some of the information necessary for EA may be available in existing records or via the consultation process. Nevertheless, it is probable that some baseline field survey and sampling will be necessary. Forward planning of baseline surveys are strongly recommended as the EA requirements for a mineral extraction licence, for example, may be onerous, costly and rigorous. The information required to evaluate the impacts of sea defences will be case-specific but could include:

- review of available information or survey of coastal geomorphology, e.g. sediment transport, erosion rates etc;
- analysis of coastal hydraulics, including currents, waves, tides and surges;
- comprehensive chemical and physical analysis of sediments where any dredging operations are intended. As a minimum, this should identify any contaminants and quantify organic content, redox potential, pH, BOD, colour, shell content and grain size;
- hydrological survey of surface and sub-surface water drainage behind the proposed sea defences;
- a comprehensive survey of terrestrial species and habitats within and adjacent to the development area, taking note of any sensitive/rare species or habitats. Statutory designated protected sites or species must be identified. In the case of dune building this should also include survey of marine benthic habitats that are possible donor sites for sand dredging;
- survey of local recreation and amenity activities in the vicinity of the development site. This should include tourist attractions, beach and inshore boat use;

- a thorough and comprehensive survey of local fishing interests would be required for an EA of sea defences where marine mineral extraction is proposed. This must involve consultation with MAFF, Sea Fish Committees, Fishing Associations, Fish Processors and Shellfish Processors;
- a landscape assessment of the area. This should identify features of interest, including designated areas, and provide data for assessment of visual impact of the development from a variety of locations, including local residences;
- review of local heritage sites, including archaeological sites of interest and shipwrecks.

## 8. Monitoring and Audit

Monitoring of environmental impacts resulting from coastal defence schemes should be conducted both during and after construction. Monitoring of coastal geomorphology, i.e. erosion processes, is important for both hard and soft engineering schemes. Intermittent wildlife and vegetation surveys would be appropriate, particularly with respect to beach and dune nourishment, to determine the recovery status of these habitats. Information from monitoring may be used to adjust a periodic replenishment schedule.

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### 9.1 Environmental Statements

Anglian Water - NRA Unit (1989) Environmental Statement - Hunstanton/Heacham beach recharge.

Anglian Water (1989) Environmental Statement - Aldeburgh sea defence scheme.

National Rivers Authority - Anglian Region (1989) Environmental Statement - Happisburgh-Winterton new sea defences.

National Rivers Authority - Anglian Region (1990) Ouse Washes Environmental Statement.

National Rivers Authority - Northumbria and Yorkshire Region (1994) Environmental

Statement - Humber tidal defence strategy: Salt End tidal defences.

## 9.2 Pollution Prevention Guidelines

- Pollution Prevention Guidelines 1: *General Guide to the Prevention of Pollution of Controlled Waters*. NRA, Bristol.

- Pollution Prevention Guidelines 5: *Works in, Near or Liable to Affect Watercourses*. NRA, Bristol.

- Pollution Prevention Guidelines 6: *Working at Demolition or Construction Sites*. NRA, Bristol.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF BEACH NOURISHMENT

See Guidance Note 38.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF SUCTION DREDGING

### 1. Introduction

This guidance note seeks to identify the potential impacts of suction dredging upon the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of operations or developments involving suction dredging. The NRA has an interest in suction dredging due to its statutory responsibilities for the protection and conservation of the water environment, navigation and flood defence. It also takes the role of competent authority that determines consent for proposed operations, such as dredging, that may affect land drainage.

In order to fulfil their statutory responsibilities drainage bodies, including the NRA, may undertake fluvial maintenance to preserve the flood capacity, navigation capability, conservation value or stability of river channels. Dredging of sediments represents one of the most common aspects of river maintenance and such works are undertaken by drainage authorities on a large scale on a daily basis across England and Wales. The main intention of such operations is to minimise the risk of flood and to aid navigation. Dredging may also be undertaken in estuarine and coastal environments to provide material for beach recharge as a form of sea defence.

Suction dredging may be undertaken by statutory drainage authorities or navigation authorities, local authorities or Internal Drainage Boards. The technique may also be used by private developers in association with construction/excavation activities for the purpose of development within the water environment.

The potential environmental impacts arising from fluvial dredging are described in Guidance Note 31. of this series and those from beach recharge as a means of sea defence in Guidance Note 38. This note is intended to complement those outlined above by examining the potential impacts of suction dredging as a general technique, although a distinction is made between possible impacts on inland and coastal waters.

### 2. Development control

Maintenance work in controlled waters fall under the Town and Country Planning (General Permitted Development) Order 1995 (SI 1995 N° 418) for the purpose of development planning. This allows permitted development rights to statutory undertakers, such as the NRA or local authorities, for land drainage works that are required in connection with the improvement, maintenance or repair of a watercourse.

New developments in or adjacent to inland waters or coastal areas that may require suction dredging in their construction are subject to normal control by a local planning authority under the Town and Country Planning Act 1990 (as amended) and usually require planning consent.

Improvements to sea defence works, such as beach recharge, are classified as favoured development under the Town and Country Planning (General Development) Order (SI 1995, Nº 418) and are granted deemed planning consent. Control over such permitted developments lies with MAFF and is implemented through the provision of grant aid.

## 3. Environmental Assessment

Dredging within a watercourse falls into the category of "drainage improvement". The Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations 1988 (SI 1988 Nº 1217) (as amended) provide a statutory procedural requirement for environmental assessment (EA) to be followed by any drainage authority in respect of improvement works that deepen, widen, straighten or otherwise improve an existing watercourse. This procedure specifies that an EA be conducted where the proposed works are likely to have significant effects on the environment by reason of their nature, size or location. It is for the drainage authority to determine if an EA is warranted. The drainage body must give notice in the local press of any land drainage improvement works, with a statement as to whether or not an EA is to be carried out for the proposed project.

Where suction dredging is used for beach recharge as a means of sea defence or coastal protection, the 1994 Town and Country Planning (Assessment of Environmental Effects) (Amendment) Regulations (SI 1994, Nº 677) apply. Coastal protection works are specified in Schedule 2 of these Regulations. As such, EA of any coastal protection development may be required by a local planning authority if a project is likely to have a significant effect on the environment by virtue of its nature, size or location.

Even where a local planning authority or drainage authority does not require a formal EA, it may nevertheless be worthwhile to undertake such an assessment. The NRA, as consenting authority for such works (see next section) may request that environmental information be made available in order to determine an application. Such information may be necessary for the NRA to fulfil its duty to further the conservation and enhancement of natural beauty in respect of proposals relating to its functions. An EA may provide the most appropriate method by which a developer may collate relevant information.

It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement or other form of report should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

Dredging of sediments from controlled waters undertaken by any drainage body or developer will require prior consent from the NRA under Section 109 of the Water Resources Act (1991) for watercourses classified as main river, or consent under Section 23 of the Land Drainage Act (1991) for unclassified watercourses.

## 5. Major potential impacts

Potential impacts of suction dredging on the aquatic environment are presented separately for dredging activities in inland and coastal waters.

### 5.1 Inland waters

Dredging is used for deepening channels or removing obstructions that have accumulated in a watercourse. This cannot be undertaken in a sympathetic manner and it is therefore important to assess the need for dredging rather than to undertake it as a fixed routine. Suction dredging is an alternative to mechanical excavation from a river bank. It will usually require a lagoon for de-watering of spoil

**Channel morphology**
The removal of river bed sediments is likely to damage a natural channel profile and cause loss of morphological variability (Brookes, 1988) as bed forms such as pools, riffles, bars and spits are either destroyed or disturbed. A fall in bed level resulting from suction dredging may cause channel adjustment up and downstream with consequent bank instability.

Suction dredging by its nature may selectively remove the smaller particles within sediments and leave behind larger ones. The maximum particle size that would be removed would depend on the type of equipment used. This could result in an increase in channel roughness, and change in the particle size distribution of a river bed.

The excavation of a river bed is likely to cause suspension of fine sediments with downstream deposition during the course of works. Although suction dredging may cause less suspension of bottom sediments in the water column than an excavator, it is inevitable that some materials would be displaced downstream. In some waters, contaminated sediments that may have been deposited in a river bed previously may be re-suspended by dredging operations.

**Water quality**
Disturbance of a river bed by suction dredging could cause increased water turbidity and sediment load. Where contaminated sediments are re-suspended by dredging operations, the resulting chemical pollution may render water unfit for use as a potable supply.

The organic content of buried fine sediments would usually have a high biochemical oxygen demand. When such particles are suspended in the water column they are likely to deplete local levels of dissolved oxygen to some degree.

**Ecology**
It should be noted that where suction dredging from a boat is used in inland waters, as opposed to mechanical excavation from a river bank, considerably less impact will be imposed on terrestrial and riparian habitats.

Benthic flora and fauna are likely to be destroyed or disturbed both at the dredging site and downstream, where siltation may occur. Benthic invertebrates will be removed in large numbers at a dredging site and may be replaced by a different community after works are completed. Similarly, downstream deposition of sediments may also cause change in invertebrate community composition. Fish spawning may be interrupted and fish eggs or juveniles damaged by material deposition on spawning grounds. In the medium term, dredging of sediments is likely to result in a reduction of ecological diversity, loss of fish spawning gravels and loss of plant cover.

Increased water turbidity during dredging operations can reduce light penetration in water and coat vegetation, thereby reducing photosynthesis and plant growth. Suspended fine sediments may also cause direct damage to fish gills and cause suffocation.

**Spoil disposal**
Spoil disposal is a major component of dredging operations and might pose serious environmental problems. If spoil is dumped at river margins, the potential impacts may include complete destruction of riparian habitat, loss of visual amenity, long-term sediment input to the watercourse and bank instability.

Where spoil from suction dredging is first de-watered in a lagoon this might have adverse impacts on land use and cause loss of natural habitat, although the intensity of this impact would depend on the siting of the lagoon. The presence of a large volume of wet material on land would probably alter groundwater hydraulics by locally raising the water table, which might in turn impact on other aspects of the environment such as land drainage, soil moisture and vegetation. Excess water removed from dredged sediments may alter groundwater or surface water quality.

Where dredged material is contaminated with metals, hydrocarbons or other industrial pollutants, its disposal to land without some form of treatment is likely to cause a variety of adverse impacts.

If spoil is removed to another site after de-watering to be used as fill material, its transport may cause considerable noise and dust impacts to local residents. Its use as fill material may also cause impacts at the receiving site, which should be investigated in an EA of such proposals.

## 5.2 Coastal waters

Material may be dredged from the sea bed specifically for beach recharge, reclamation projects or to provide depth for navigation. Beach recharge, or nourishment, has been seen as an attractive alternative to coastal protection schemes with hard structures (Oorschot & Raalte, 1991), as it represents a more natural form of beach protection. Material is usually dredged from the sea bed at some distance from the shore and pumped or carried by barge to the shore. It is then spread either by dumping from a barge or by spraying from a pumped system.

**Coastal morphology/Water quality**
Excavation of the coastal sediments by suction dredging is likely to drastically alter the local morphology and particle composition of the sea bed. This may in turn affect local tidal flows and wave patterns and sediment regimes, resulting in erosion and disposition

in areas previously perceived as being relatively stable.

Suspension of sediments during pumping operations may increase water turbidity and also cause organic pollution. Fine sediments act as a sink for many pollutants introduced into the marine environment and dredging operations may cause re-suspension of such contaminants. This may be a particular cause for concern where potentially toxic material such as sewage sludge or industrial wastes have been dumped at sea, as the consequent chemical pollution of coastal or inshore water could be severe.

**Coastal ecology**
Suction dredging can have major impacts on sea bed ecology including loss of sea bed flora and less mobile fauna. Fine material suspended by dredging operations may increased turbidity and attenuate the penetration of sunlight into the sea, thus reducing photosynthesis of plants and algae. Only where the ambient turbidity is already very high will the impact of suction dredging be negligible. The food intake of filter-feeding zooplankton and benthic invertebrates may decrease as the ratio between edible plankton and inedible silt is disturbed (Adriaanse & Coosen, 1991).

The direct physical impacts of suction dredging, such as removal of bottom material and suspension of sediments, may result in the loss of fish spawning areas and change fish behaviour. These impacts are also likely to alter sea bed habitat, reduce species diversity and change invertebrate and plant biomass in an area extending outside that used for dredging, as such activity has some effect beyond the immediate area of excavation in shallow waters (CIRIA, 1991).

**Spoil disposal**
Where suction dredging is used for beach recharge there may be some disruption to beach and pleasure craft users. The storage, spraying, spreading and deposition of large quantities of dredged material may result in an increase of the normal level of wind-blown sand. This may cause nuisance to nearby residents and may be detrimental to adjacent agricultural land.

Where sea bed material contaminated with heavy metals is pumped ashore for beach recharge or a reclamation project and subject to rainfall and drainage, the resulting change in redox potential and pH could release the heavy metals from the sediment. This could pose a risk to the quality of inland surface or inshore coastal waters.

## 6. Mitigation measures

Measures to reduce or avoid the impacts of suction dredging will depend on the environment that is dredged and the intended use of spoil material. Many of the mitigation measures for fluvial dredging that are described in Guidance Note 31. of thisseries and those relevant to beach recharge described in Guidance Note 38. are applicable to suction dredging. Some techniques for reducing the impact of mud dredging in harbours are identified by Kirby (1994).

- Working practices should follow the appropriate NRA guidelines (NRA, 1994).
- Phased working, such as dredging in small sections or part of a river channel, should

be used where possible. This allows refuges for plants and animals and assists subsequent re-colonisation. It may take the form of dredged strips across or along one side of the channel, or in a zig-zag pattern up the channel. A similar strategy should be adopted for inshore dredging of coastal waters.
- Sensitive periods, such as the fish spawning and bird breeding seasons, should be avoided wherever possible.
- Suction dredging within river channels should be undertaken at periods of low flow to minimise silt disturbance.
- Suction dredging undertaken within inshore coastal waters, estuaries or the tidal reach of rivers should take place on the ebb tide.
- Dispersion of fine sediments caused by dredging should be minimised by the construction of a temporary silt trap.
- Where spoil dredged from rivers or lakes must be de-watered, the lagoon should be situated away from sites of conservation, recreation or amenity value.
- Disposal of supernatant from settlement lagoons should be undertaken only after consultation with Water Quality (Pollution Control) staff of the NRA.
- Where sediments are known to be contaminated, dredged spoil should be treated by washing and secondary processing, if necessary, to remove metals and hydrocarbons before disposal.
- Spoil from suction dredging may have commercial value as an aggregate or fertiliser and should be disposed of in this manner where possible.

## 7. Baseline surveys

The type of baseline information suitable for use in EA of suction dredging will vary with location and the proposed scheme. In inland waters a thorough geomorphological survey of the watercourse and river corridor survey (NRA, 1992) of all areas to be directly affected by dredging and de-watering activities would be required.

In coastal areas, where suction dredging is used for beach recharge, an evaluation of the existing landscape, conservation and amenity value of the area would be appropriate, although these would be required whatever method is used for obtaining recharge material. A survey of local coastal erosion and deposition processes should also be conducted, to provide a clear picture of the sediment regime of the area.

In all cases, a sediment composition survey should be undertaken, particularly for inland waters. This should assess the physical and chemical characteristics of the material to be dredged and examine its redox potential and pH in relation to possible leaching of metals. The organic content of sediments should be determined.

## 8. Monitoring

On-site supervision of suction dredging by an environmental specialist should be arranged, particularly if sensitive habitats or species are likely to be present in the working area. Other monitoring programs will depend on the type of scheme for which suction dredging is intended and information is provided in Guidance Notes No. 31 and No. 38.

## 9. References and guidance

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF THE RESTORATION AND ENHANCEMENT OF RIVER CHANNELS

## 1. Introduction

This guidance note seeks to identify the potential environmental impacts arising from the restoration and enhancement of river channels. It is intended to act as a scoping brief for environmental impact studies of such developments. The National Rivers Authority (NRA) has an interest in the restoration and enhancement of river channels due to its statutory responsibility for the protection of the water environment under the Water Resources Act 1991 (WRA). This Act also imposes a general duty on the NRA to promote the conservation and enhancement of the natural beauty and amenity of inland waters and associated land. In order to fulfil these responsibilities the NRA promotes river rehabilitation where this may provide a more natural channel morphology and enhance the habitats associated with a riverine environment.

River restoration or enhancement schemes may be undertaken by drainage bodies as part of flood defence or other land drainage improvement works, by private developers who wish to mitigate the impact of development adjacent to rivers, or by riparian owners.

The aim of river restoration is to reverse detrimental impacts of channel modification that have been imposed on many watercourses in the past. This has taken the form of large-scale straightening, deepening and culverting of river channels, which has often damaged wildlife habitats, reduced the value of fisheries and removed much of the natural aesthetic appeal of river landscapes. Also, as a result of urban and agricultural flood defence, land drainage and floodplain urbanisation, there has been a major loss of floodplain wetlands which has destroyed wildlife habitats and reduced floodplain water and sediment storage capacity. In practice, most river restoration schemes can only partially amend these adverse impacts because of the need to protect buildings or valuable agricultural land.

The goal of most river improvements is to restore a watercourse to a more natural state and increase morphological variability and habitat diversity. Improvements can take the form of river restoration, which aims for a complete or partial structural and functional return of the watercourse to the natural 'pre-disturbance' state, or river enhancement, which refers to any structural or functional improvement. River restoration concentrates on creating self-sustaining, stable and diverse ecosystems, whilst river enhancement may be undertaken through river maintenance operations (Holmes, 1993). Some improvements may be relatively minor, such as the creation of sediment bars, riffles or in-stream islands, whilst others may be very large indeed. The Kissimmee River Restoration Project in Florida for example, involves the re-establishment of 70 km of river channel and 11,000 ha of wetland habitat (Koebel, J.W. 1995; Shen, H.W. *et al*, 1994). Projects within the UK are naturally smaller than this, an example being the restoration of the River Cole at Coleshill (NRA, 1995) which will affect a 2 km reach of river and 50 ha of floodplain.

## 2. Development control

River improvement works undertaken by drainage authorities fall under the Town and Country Planning (General Permitted Development) Order 1995 (SI 1995 Nº 418) for the purpose of development control. This allows permitted development rights to these drainage authorities (as statutory undertakers) for development in, on or under any watercourse or land drainage works that are required in connection with their improvement, maintenance or repair. The authorising body for such channel works is the Ministry of Agriculture Fisheries and Food (MAFF).

Restoration of a river channel undertaken by a private developer as a means of mitigating the impacts of development on the water environment will require planning permission under the Town and Country Planning system, where such works comprise an integral part of a larger development proposal. The NRA is a statutory consultee for development involving works or operations in the bed of, or on the banks of a river or stream.

Enhancement of a river channel as a means of impact mitigation or habitat improvement would not usually require development consent where works do not physically alter the configuration of a river or create new structures. Nevertheless, whether the proposals would require consent or not would depend on precisely what form the channel enhancement would take, and developers should consult with their local planning authority to establish whether or not planning permission is required

## 3. Environmental Assessment

There is no specific requirement for Environmental Assessment (EA) of river improvement schemes under the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199). Nevertheless, a formal EA may be required if such a scheme forms part of a development proposal identified by the Regulations as requiring mandatory or discretionary EA. It is for the local planning authority to determine whether an EA is necessary.

The Land Drainage Improvement Works (Assessment of Environmental Effects) (Amendment) Regulations 1995 (SI Nº 2195) places an obligation on any drainage authority proposing to carry out improvement works that deepen, widen, straighten or otherwise improve any existing watercourse to undertake a prescribed procedure. The drainage authority must consider whether, by reason of its nature, size or location, the proposed project is likely to have significant effects on the environment and ought therefore to be made the subject of an EA. It is for the drainage authority to determine if an EA is warranted. The Regulations require a drainage body to give notice in the local press of any proposed land drainage improvement works, including river restoration schemes, with a statement as to whether or not an EA will be carried out for the proposed project.

Even where a formal EA is not required by the above Regulations, it may nevertheless prove worthwhile for any developer to conduct some form of assessment. The NRA, as consenting authority for land drainage (see next section), may request environmental information concerning a development proposal in order to determine an application for land drainage consent. This results from its duty under the 1991 Land Drainage Act to further the conservation and enhancement of natural beauty in respect of proposals relating to its functions. An informal EA may provide the most appropriate method for collating relevant information.

It is recommended that the conduct of an EA and subsequent preparation of an environmental statement or informal report follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

River restoration or enhancement works will require prior consent from the NRA under either Section 109 of the WRA for watercourses designated as main river, or under Section 23 of the Land Drainage Act (1991) for unclassified watercourses. Consent under the Land Drainage Bylaws may also be applicable in some areas.

## 5. Major potential impacts

There are two main approaches to undertaking river restoration. Natural recovery can be encouraged, where suitable streams or rivers are allowed the freedom to recreate their own physical course and flooding regime. Alternatively, active restoration can be undertaken, where intervention is needed to modify rivers that are too badly damaged or have too little sediment supply and energy to repair themselves. Information concerning the potential for river restoration in Britain and options available for such schemes are given in ECON (1993). An examination of some of the wider issues involved in river restoration is provided by Brookes (1988) and Boon *et al* (1993).

This Guidance Note deals only with the potential environmental impacts resulting from the active improvement of river channels. A wide range of techniques may be used in such river restoration or enhancement schemes. These include physical alteration of a river channel meander pattern, channel profile, bank profile, riffle/pool sequence and substrata. In addition, landscaping and vegetation management of riparian and/or floodplain areas may also be applied. This section examines the potential impact of such activities in both the construction and end-state of a project.

### 5.1 Construction

River restoration works may involve earth-moving, including dredging, landscaping and introduction of materials such as gravel, rocks and vegetation. The impact of construction activities is discussed only briefly here; other Guidance Notes in the series relevant to this phase of such schemes are:
- No. 1 - General Construction
- No. 31 - Channel Works (incl. fluvial dredging)
- No. 32 - Bank Protection

### 5.1.1 Water quality

Channel realignment and/or channel dredging are likely to cause disturbance of sediments. This could result in adverse impacts on water quality during the construction period. Increased turbidity of a watercourse may decrease plant photosynthesis due to light attenuation and thereby reduce oxygenation of the water. In some watercourses it is possible that contaminated sediments trapped in the river bed or stored in a floodplain will be re-suspended by dredging or realignment operations. This may pose a particular risk to water quality where old gravel pits have been filled with waste material, even if the material is documented as being inert (Brookes, 1995).

### 5.1.2 Geomorphology/hydrology

Considerable redistribution of sediments may result from river dredging or channel realignment, with possible change to the downstream riffle/pool sequence, bed slope or channel width. These are dealt with in more detail in the section covering end-state impacts.

### 5.1.3 Wildlife

Increased suspended sediments during dredging operations may cause direct damage to fish gills and in extreme cases could cause suffocation. Increased turbidity could also reduce light penetration in water and thereby reducing photosynthesis and plant growth.

Downstream deposition of material during dredging operations may smother existing benthic and/or emergent habitats. Fish spawning may be interrupted and fish eggs or juveniles damaged by material deposited on spawning grounds. Fish species not adapted to a depositional environment may be temporarily replaced by species that are. Similarly, wildlife such as birds or mammals will undergo considerable disturbance in the vicinity of a work site and there is likely to be a temporary displacement of sensitive species.

A serious impact of construction activity is likely to be the disturbance or destruction of existing habitats within and adjacent to a river and along any temporary access routes used. This may include wetland, marginal, riparian and terrestrial habitats, and also mature woodland or hedgerows. At least some of these may have amenity or conservation value. Compaction of topsoil is likely to occur and unfelled trees may be damaged by comprehensive trimming and lopping of branches to allow access. As the intention of a river improvement scheme would be to enhance or improve habitat diversity along a river corridor, the impacts of such disturbance/destruction must be weighed against the eventual gains in terms of conservation interest and wildlife potential.

Where dredging or realignment is used in river rehabilitation, spoil disposal may pose an environmental problem. If spoil is dumped at a river margin the potential impacts include complete destruction of riparian habitat, loss of visual amenity, long-term sediment input to the watercourse and bank instability. If spoil is removed to another site, its transport may cause considerable noise and dust impacts to local residents. Spoil transport may also cause impacts at the receiving site, which should be investigated in an EA.

### 5.1.4 Human-related

Construction activity is likely to cause disturbance to human beings in terms of adverse visual impact and restricted access to the river for recreation or amenity. Noise or dust created by construction work may also cause adverse impacts to local residents.

## 5.2 End state

Many beneficial impacts of river rehabilitation or enhancement, such as the creation of a more natural flooding regime, a more diverse corridor habitat, improved water quality or increased recreation/amenity value, will be inherent in the rationale for a particular project. This Guidance Note concentrates primarily on potential adverse impacts associated with such schemes as, if these are identified at the planning stage of a project, its design can be amended to avoid or minimise them. Other Guidance Notes of this series that may be relevant to impacts of particular schemes are:

- No. 30 - Flood Diversion Channels
- No. 45 - Vegetation Management

### 5.2.1 Land use

Alteration of channel width, direction or sinuosity is likely to result in land-take directly adjacent to the existing watercourse. This may be agricultural land, natural habitat, residential gardens or commercial property. Some land-take will only be temporary for the duration of works but a portion may be permanent.

Whilst some river restoration projects may involve direct loss of productive farmland, others could exert an indirect impact on land use. Certain areas of agricultural land may become less productive as a result of the restoration work, possibly through a raising of the water table or an increased frequency of small flood events. This may result in crop and/or stock restrictions, whilst access to some land may become seasonally inhibited.

Re-meandering of a watercourse may also impose restrictions on the future development potential of adjacent land.

### 5.2.2 Channel morphology

Reinstatement of the natural sinuosity of a river is likely to slow river flow, as river bed slope is reduced. This could result in increased deposition of mud and silt within and below the affected area after restoration is complete, which may cause a substantial change in channel bed characteristics for some distance downstream. Also, an increased meander pattern could lead to a heightened erosion force on some areas of river bed and bank, although a reduced water velocity may off-set this. Such erosion could also cause downstream siltation and create localised bank instability.

Where dredging is undertaken, this could result in a loss of morphological variability in some areas of a river channel. Dredging may also locally lower a river bed level which may cause channel adjustment up and downstream, loss of pool-riffle sequence and bank instability.

The profile of a river channel may be changed by rehabilitation works. Change of bank profile, pool and riffle construction or reinstatement of substrata may all modify channel size and/or river bed slope and encourage deposition of material where river velocity is reduced. The creation of stream habitat devices such as islands will also change a channel profile and may result in increased bed/bank erosion with subsequent downstream deposition.

### 5.2.3 Hydrology

Many aspects of river restoration can increase the rugosity, or roughness, of a river channel and some, such as riffle creation, may also raise the bed level of some channel areas. Increased rugosity is likely to slow river velocity and could increase the frequency, magnitude and duration of flood events, although other factors such as channel width, bank profile and floodplain characteristics will also influence the likelihood of flood.

Alteration of bed slope and channel meander may cause a local rise in groundwater level (water table). This could exert an impact on land surface drainage for a considerable distance from a river.

Before consent is granted for a restoration or enhancement scheme, the developer would be required to prove that proposals do not increase the frequency, duration or intensity of flood events.

### 5.2.4 Water quality

Increased channel rugosity provides an opportunity for increased oxygenation of river waters. However, the overall reduction of river velocity associated with an increased meander pattern and reduced bed slope is likely to have an opposite effect. Where new meanders and riffle/pool sequences are created oxygen depletion may occur in areas of deep, slow-moving water. This may be enhanced by an increased nutrient input from adjacent agricultural land where low-intensity flood events might occur.

Any overall increase in river bed or bank erosion will be reflected in a change in water turbidity.

### 5.2.5 Aquatic ecology

Where dredging is used in a restoration scheme the potential long-term ecological impact on the aquatic environment will depend on the techniques used. Most, if not all benthic invertebrates and plants are likely to be destroyed in the locality of dredging operations. If the hard bed is unbroken by dredging then plants recover quickly; if the bed is destroyed but silt accumulates then plants will recolonise this (Haslam, 1978). However, if the substrate is unstable following works, and there is no associated sediment deposition, then vegetation returns only very slowly (Brookes, 1988).

Material deposition and siltation resulting from a reduction in flow velocity may alter existing marginal habitats outside of the restoration area. Increased deposition may encourage the growth of emergent vegetation, although this may be considered a beneficial impact. Existing marginal habitats may be subject to small flood events, in part due to sedimentation processes and in part as a result of a slightly higher water table.

A change in water velocity or depth within a river channel is likely to alter the species composition and diversity of its plant and animal communities. For example, a local reduction in water velocity would favour those macrophytes best adapted to slow flow at the expense of species suited to faster velocities. Altered conditions of flow are also likely to change the species composition and diversity of indigenous invertebrate and fish communities. These changes should prove to be beneficial impacts in most cases, as the increased diversity of habitats likely to be seen within a restored or enhanced river channel would encourage species diversity within all aquatic communities.

### 5.2.6 Terrestrial ecology

Terrestrial and riparian habitats may suffer temporary disturbance or destruction during construction activities as mentioned earlier. In addition, restoration of a river channel could result in flooding of existing riparian and floodplain areas. In some cases this may be permanent and lead to the establishment of new wetland habitats. In others, flood may be seasonal or periodic with consequent changes in soil structure, vegetation and wildlife.

### 5.2.7 Landscape/archaeology

The use of machinery and other construction activities during channel restoration may cause short and medium-term adverse impacts to landscape character. This could take the form of loss of natural features or features of visual interest, or loss or change in vegetative cover. Restoration works themselves are likely to be intrusive in any landscape setting. In the longer term however, the impact of river restoration or enhancement is likely to be highly beneficial to landscape character, particularly within an urban or semi-urban landscape.

Sites of environmental, archaeological or historical interest could be affected by land-take, excavation or construction machinery as a result of channel restoration works. Lasting damage or disruption to such sites should be considered a very significant adverse impact, particularly where a statutory designated site may be affected.

### 5.2.8 Human-related

Most impacts of river restoration on the recreational and amenity value of a watercourse and surrounding land are likely to be beneficial. Nevertheless, some restriction of access to a river channel may occur and creation of islands may disrupt navigation, water-based recreation activities and change angling quality.

Any increase in the frequency, duration or intensity of flood events as a result of river restoration may pose a risk to human life or property.

## 6. Mitigation measures

Mitigation measures are presented here under headings of 'construction' and 'end-state'. It should nevertheless be recognised that these are contingent on adequate project design and cannot easily be implemented once river restoration has begun. Accordingly, mitigation measures listed here under 'end-state' are, in effect, design considerations.

A comprehensive guide to river management practice that may benefit wildlife is provided by *The New Rivers and Wildlife Handbook* (RSPB *et al* 1994). This publication contains a wealth of information on suitable techniques for channel and bank works, vegetation establishment and management, and survey methods.

### 6.1 Construction

- Publicity should be provided during construction to inform the public of the rationale for river rehabilitation works, the estimated time-scale of construction and the projected final environmental benefits. This may take the form of on-site signboards and notices in local newspapers. Publicity should go beyond statutory obligations in the provision of information.
- On site supervision of working practices should follow the appropriate NRA guidelines (NRA, 1994).
- Movement of construction plant and materials should be limited to normal working hours.
- Works should avoid sensitive periods for wildlife, such as the fish spawning and bird breeding seasons, where possible.
- Works should be undertaken during periods of low flow to minimise silt disturbance. If a restoration scheme is within a tidal reach, dredging should be carried out on the ebb tide.
- Downstream siltation due to construction activity can be avoided by use of a temporary silt and sediment trap.
- Phased working, such as dredging in small sections or part of the channel, should be used to allow refuges for plants and animals and assist subsequent re-colonisation.
- Dredging should be undertaken in an upstream direction so plant roots and animals released during excavation can drift and re-colonise sections already completed.
- Spoil from river dredging may have commercial value as an aggregate or fertiliser and should be disposed of in this manner where possible.
- Sensitive riparian habitats and mature trees adjacent to a river should be avoided wherever possible.
- Tree surgery should be carried out with the assistance of a qualified arboreculturalist.
- Existing vegetation could be transplanted where the only other option is destruction. Vegetation can be stored for on-site replacement after works are complete.

## 6.2 End-state

- Reinstatement of natural substrata such as gravel should use local materials wherever possible.
- Sufficient depth of gravel should be provided to allow for natural processes of erosion and deposition.
- Where riffles, pools or sediment bars are created the size and distribution of bed material should be appropriate so the features are self-maintaining.
- Reprofiling of river banks should ensure a variety of style, including steep, moderate and shallow slopes with some unevenness, to avoid visual and habitat uniformity.
- Aquatic and marginal habitat diversity should be encouraged by the creation of a wide variety of physical environments such as bare ground and cliffs, sloping banks, marginal shelves, riffles, ponds, pools and backwaters.
- An appropriate riparian landscaping scheme, including tree planting, should be undertaken.
- Replacement planting should be undertaken with appropriate local species. Non-local species are acceptable only where necessary as a 'nurse crop', and where natural succession will rapidly result in their disappearance.
- Areas of natural habitat should be encouraged to form adjacent to the river channel.
- A vegetation and general maintenance program should be designed and implemented for the first few years after restoration works.

## 7. Baseline surveys

Baseline surveys of environmental components within the catchment and reach affected by river improvements will be necessary for EA, although the data required will vary from site to site. A comprehensive geomorphological survey of the river and a river corridor survey (NRA, 1992) must be considered as essential baseline information required for EA of all river restoration projects. Other surveys likely to be necessary are:

- A survey of aquatic and marginal habitats and species. This will identify any protected species and can be used as a monitoring baseline for biological diversity.
- Hydrological and water quality data concerning the catchment and reach affected. This should include historical data where it is available.
- Survey of landscape characteristics. This could take the form of a river landscape assessment (NRA 1993).
- Physical and chemical analysis of sediments. This must be undertaken where dredging operations are intended in any area likely to contain industrial contaminants etc.

## 8. Monitoring

An appropriate monitoring strategy should be designed and implemented to confirm the predicted impacts of the works on water quality, sediment distribution and the flora and fauna of aquatic and riparian habitats. The effectiveness of mitigation measures should be assessed. This information can be used to evaluate the success of a river restoration project (Kondolf, 1995). It has been suggested that post-project monitoring be continued for at least ten years (Kondolf & Micheli, 1995).

Surveys conducted to gain baseline information should be repeated at regular intervals.

The intention should be to check the geomorphological stability of the restored channel and to confirm establishment of new habitats and colonisation by new species.

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## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CONSERVATION ENHANCEMENTS

See Guidance Note 41.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF WATER-BASED RECREATION

## 1. Introduction

This guidance note seeks to identify the potential environmental impacts of water-based recreation activities and associated developments. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such activities or developments. The NRA has an interest in water-related recreation owing to its statutory responsibilities under the Water Resources Act 1991 (WRA) with respect to the protection of the water environment. The Act also lays down a general duty for the NRA to promote the recreational use of inland and coastal waters and associated land.

Water-based recreation as examined in this guidance note includes those activities such as bird-watching and angling, where participants are based on land and require little in the way of water area or facilities. It may also prove relevant to water-related activities such as walking or cycling in areas where water may act as a focus as, for example, on riverside footpaths and cycleways. The guidance note also encompasses water-based sports like canoeing, rowing, sailing, wind surfing, and sub-aqua diving that may require facilities such as access points, car parking, boat/clubhouse or slipways. Some of these may also require a moderate to large area of water. Finally, it also includes water skiing, hydroplaning and power boating, activities that generally require special facilities such as firm slipways, jetties, fuel points and large clubhouses and usually take place on larger areas of water. All these recreational activities may take place on, or adjacent to, inland or coastal waters.

It has been noted that, compared with other activities, leisure and tourism do not cause significant widespread ecological damage to the countryside (House of Commons, 1995). While this may be the case from a national perspective, there can be no doubt that recreational developments and activities, including those that are water-related, can result in intense localised environmental impact at "honeypot" locations in peak season. The cumulative effect of many recreational developments or activities may cause environmental or aesthetic damage over a large area of river catchment or coastline.

The NRA wishes to encourage recreational use of the water environment. The social and economic benefits of such pastimes are considerable, particularly in rural areas. However, the intention of this guidance is to indicate some of the potential adverse impacts of water-based recreation and to suggest mitigation measures that may be introduced. This is not to imply that social and economic impacts are of no importance but simply that they are beyond the scope of this guidance note, which concentrates on the water environment. With appropriate development planning, project design and recreational practice, the environmental impacts of water-based leisure activities may be avoided or minimised. This accords with the principles of "Green Tourism" identified by the House of Commons Environment Committee. In this way, the principle of sustainability may be introduced into water-based recreation and the diverse benefits of these activities enjoyed by all, without detracting from the quality of our environment.

## 2. Development control

New facilities for inland water-based recreation activities will generally require consent from a local planning authority under the Town and Country Planning Act 1990 (as amended) in areas under their jurisdiction (i.e. inland and some coastal areas). Other development control may also be relevant in these and other areas as the Department of Transport has powers to control works affecting navigation and the Ministry of Agriculture Fisheries and Food has powers to control construction projects in the sea.

## 3. Environmental Assessment

No developments likely to be associated with the water-based recreation activities mentioned above are identified in the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) as requiring Environmental Assessment (EA). Marinas are listed as a Schedule 2 project under the Regulations but such developments are examined in Guidance Note 3. of this series and are not dealt with here.

Although EA of developments associated with water-based recreation may not be required by a local planning authority, it is nevertheless good practice to undertake such an assessment. The NRA, as competent authority for determination of consent for discharges to the water environment, and also for some developments in certain waters, may request that certain information be made available in order to fulfil its obligations toward protection of the water environment and flood defence. Where a development proposal associated with water-based recreation is likely to require NRA consent, an EA may provide the most appropriate means by which a developer can present relevant environmental information. It is recommended that the conduct of an EA and subsequent preparation of a report should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

Statutory controls over discharges affecting the water environment are contained in Section 85 of the WRA. Under this legislation it is an offence to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste to enter controlled waters. This includes sewage effluent and also any matter that may impede the proper flow of inland waters. It also includes the use of sea toilets on navigable waterways. No offence is committed where the NRA has determined a consent under Section 88 of the WRA. The NRA may place conditions upon a discharge consent regarding the place of discharge, its nature and treatment prior to discharge. Discharge consents are reviewed after a minimum period of two years and the NRA may then vary or revoke a consent.

Under Section 109 of the WRA 1991, NRA consent is required for the erection of any structure in, over or under a watercourse which is part of a main river. With respect to water-based recreation, structures requiring consent may include slipways, jetties, fuel points and boathouses.

## 5. Potential impacts

This guidance note outlines the potential impacts on the environment both of recreational activities and development of their associated facilities, where applicable.

Impacts upon the water environment may be of concern to the water quality and flood defence functions of the NRA. Potential impacts on other environmental components are also examined here as, in considering proposals relating to its functions, the NRA has a duty under Section 16 of the WRA:
- to have regard to the desirability of preserving for the public any freedom of access to areas of woodland, mountain, moor, heath, down, cliff or foreshore and other places of natural beauty; and
- to take into account any effect which the proposals would have on any such freedom of access.

In addition, Section 12 of the Land Drainage Act 1991 obliges the NRA, in formulating or considering any proposals relating to its functions, to:
- further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological and physiographical features of special interest; and
- to take into account the effect the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects.

### 5.1 Construction of facilities

Some water-related recreational activities require little in the way of associated facilities whilst others may demand stairways or slipways into water, jetties, fuelling points, fuel storage facilities, car parking areas, boathouses, clubhouses, showers and toilets.

Potential impacts on the water environment arising from construction activities are described in Guidance Note 1. of this series (General Construction). Other guidance that may be relevant to new developments for water-based recreation include:
- Guidance Note 3. (Marinas)
- Guidance Note 28. (Navigation Works)
- Guidance Note 32. (Bank Protection)
- Guidance Note 53. (Camping & Caravan sites)
- Guidance Note 54. (Septic Tanks/Cesspools)
- Guidance Note 55. (Vehicle Parks/Plant Hire)

The impacts of construction works of even small developments associated with water-based recreation may be very significant due to the proximity of watercourses, other freshwater bodies or inshore coastal waters. It is not possible to describe all potential impacts of such construction here, as these will depend on the type of development proposed and the site characteristics. Consideration of each development in the context of its setting is a necessary component of any EA.

The development of recreational facilities is likely to have considerable social benefits unlike for example, the construction of an office block, although both types of development may have similar adverse impacts when situated adjacent to surface waters. An EA of any recreational development should include such benefits in its impact evaluation, although they are not described here.

### 5.1.1 Works on land

Construction of recreational facilities is likely to result in land-take directly adjacent to a water body. This may be agricultural land, natural habitat or sites of environmental or archaeological interest. Land-take may be only for the duration of works, or permanent.

Works may cause disturbance and disruption to local residents, businesses and users of the area. This may be as a result of noise or dust emanating from construction activities, or the closure of roads or footpaths while construction work is undertaken. The works may also result in a temporary loss of amenity for water users, navigation rights may be impeded and boat moorings or other facilities may be made inaccessible for a time.

Machinery used in construction works on land may cause compaction of topsoil which may interfere with riparian drainage. Excavation of foundation trenches, underground storage facilities or pipelines and subsequent disposal of soil may result in washing of loose material into nearby water, causing an increase in turbidity and deposition of sediments.

Construction activities on land may cause direct destruction of terrestrial and riparian habitats and flora. This may include the loss of mature trees and other vegetation that act as breeding or feeding sites for wildlife, including birds, provide shade to the margins of a water body and help to combat riverbank erosion. In turn, this may result in the disturbance or loss of insects, mammals and birds. Even minor construction work, such as the provision of access and fishing platforms for anglers or viewing sites for bird-watchers, may cause destruction of terrestrial vegetation and alter habitat characteristics.

### 5.1.2 Works in water

The construction of any structure in water, such as an access ramp, jetty or revetment will inevitably result in direct destruction of marginal and aquatic habitats and species. It is also likely to cause disturbance of sediments with consequent increased water turbidity and sediment deposition elsewhere. Suspended solids may damage fish through abrasion of the gills and reduce photosynthesis of rooted plants or algae by attenuation of sunlight. Deposition of material away from a construction site may smother benthic organisms and may cause change in an aquatic community, where organisms adapted to a depositional environment are favoured.

Construction work may disrupt access to water, navigation, angling and other water-based or water-related activities. The creation of any structure in or at the margins of the water environment may cause an adverse visual impact, particularly where the site is within an area of high aesthetic value.

## 5.2 Recreational activities

The environmental impact of water-based recreational activities cannot be separated from the impact of their associated facilities. These are described below as they affect individual environmental components.

### 5.2.1 Surface water hydrology

**Facilities**

The creation of a large impervious area of land surface for buildings, car parks or slipways may result in significant alteration to existing surface water runoff. If rainwater flows directly to a water body, land surface or riverbank/shore erosion may occur. Rapid runoff may also cause localised erosion of river or lake bed where it enters the water body.

An increase in the intensity of local flooding is likely in periods of high rainfall due to the rapid runoff of surface water from covered areas. This may cause significant additional bed and bank erosion that may be detrimental to any existing flood defence works.

The erection of any new structures associated with water-based recreation within the floodplain of a river could reduce the capacity of the floodplain to store water and inhibit the downstream and lateral movement of floodwaters. Buildings, ancillary structures, fences and tree planting may all obstruct the passage of flood waters. Such impediments to flood defences may result in an increased risk to property and human life.

**Activities**

Some boating activities, particularly power boating and water-skiing are likely to generate substantial waves and sub-surface water turbulence that may affect the temperature or saline stratification of a water body.

### 5.2.2 Surface water quality

**Facilities**

Rainwater runoff from a vehicle park or boat storage facility is likely to be contaminated with suspended solids, metals, hydrocarbons and oxygen-depleting substances. Similarly, boat maintenance or refuelling facilities are likely to store quantities of oil, fuel and solvents that, by virtue of poor storage, handling or disposal, may pollute a water body.

Erosion associated with rainwater runoff from large covered areas may cause increased water turbidity and sediment load.

Where recreational facilities contain showers or toilets not connected to the public foul-water system, the presence of micro-organisms would pose a health risk to humans should sewage effluent enter surface waters. This would be a particular cause for concern as any such development is likely to be situated within an area where water-based recreational activity is common.

**Activities**

Water pollution from motorised water-based recreation activities may occur by leakage or accidential spillage of chemicals during refuelling, maintenance or cleaning of boats or yachts. Pleasure boating, yachting and boat fishing may also contaminate the water environment through the release of oil, fuel, chemical or organic materials from outboard motors and submerged exhaust emissions. Although any individual release of a contaminant may be minor and the number of boats used for any one activity, e.g. water-skiing, may be small (UK CEED, 1993) the cumulative impact of such pollution on water quality, particularly in confined waters, may be considerable.

### 5.2.3 Geomorphology

**Facilities**

Erosion caused by surface runoff from a parking area may alter the geomorphological profile of a watercourse or in-shore area of any water body. The pattern of sediment distribution may be changed, with siltation of some parts and scouring of others. Sections of bank/shore may be weakened or collapse entirely as a result of excessive surface and subsoil drainage.

**Activities**

Walking or cycling near water, and activities such as bathing, bird-watching and angling, which are usually carried out at the land/water interface, may cause direct erosion of river banks or shoreline and disturbance of surface water drainage through trampling of vegetation and erosion of footpaths. Canoeing may cause similar impacts where access to water is gained in remote areas and through canoe portage around in-stream obstructions. In addition to erosion caused by human access, excavation of informal fishing platforms in steep river banks by anglers may destroy vegetation that acts to stabilise a river bank, thus leaving it vulnerable to erosion by wind and water.

Motor driven boats that are used for water skiing, fishing, pleasure boating or racing may cause increased erosion of river banks or lake shores as a result of waves and turbulence generated by both hull and propellers. The erosion potential is most intense during acceleration and deceleration of a boat. This can pose a serious threat to bank and shore stability. High speed boats are likely to expedite and spread such erosion well beyond what may be expected in natural fluvial systems (Bradbury *et al*, 1995). The characteristics of river banks or shoreline, the distance boats operate from a shore, the level and depth of water are all variables that are likely to affect the rate and extent of boat-induced bank erosion.

### 5.2.4 Aquatic ecology

**Facilities**

Some pollutants entering inland or coastal waters from an area used for vehicle parking, boat maintenance, refuelling or cleaning may be toxic to all aquatic life. Most fuels, lubricants and solvents fall into this category and these may cause extensive invertebrate and fish kill. Even low levels of pollutants such as hydrocarbons and solvents may cause loss of sensitive species. Compounds that possess a high biochemical oxygen demand may cause localised invertebrate and fish kill due to oxygen depletion. Other contaminants, such as suspended solids, may act to inhibit benthic or planktonic flora and so disturb existing aquatic communities.

An increased intensity of flooding after rainfall may destabilise an aquatic community. Erosion and/or siltation resulting from rapid surface runoff from covered areas may cause change to the species composition of the benthos. Erosion is likely to inhibit the presence of benthic algae and invertebrates, while siltation may allow only those animals adapted to living in mud and silt to remain.

Increased turbidity associated with land, bank or bed erosion may directly injure fish by abrasion to the gills. Such turbidity may also alter fish behaviour. Deposition of material within a water body may disturb fish spawning areas and thereby reduce the angling and/or fisheries value of inland or in-shore waters.

**Activities**
Bird-watching, angling, canoeing and other activities that often require access to water through a natural riparian or shore environment may cause destruction of bankside vegetation and disturbance of marginal habitats and species. Such impacts are not confined to open waters as bird-watching, for example, may involve trampling of sensitive wetlands such as reed beds, peat bogs and estuarine mudflats. Similar impacts may be caused to the benthos of rivers, where canoeists may physically disturb spawning salmonids or fish spawning gravels.

Marginal, aquatic, wetland and estuarine vegetation may be physically damaged by boat-induced waves and/or turbulence. Vegetation such as reed beds that depend on a depositing environment may be deprived of this by the erosive action of boat waves. Alternatively, sediments suspended by the turbulence of propellers may act to smother aquatic flora in backwater areas where deposition may occur. Boat propellors may also directly cut aquatic vegetation and prevent re-growth (Liddle & Scorgie, 1980).

Noise from motor driven boats or human movement during some other water-based recreational activities may cause temporary and localised disturbance to feeding, roosting and nesting birds, including aquatic wildfowl. Coarse fishing, sailing and rowing have been judged to exert a significant impact on winter wildfowl numbers (Tuite *et al*, 1984) although bird-watching, which is frequently associated with active conservation management, is usually related to an increased species diversity.

The introduction of contaminants, suspended solids and water turbulence caused by various recreational activities may have an adverse effect on aquatic wildlife. The migratory behaviour of fish may be altered and spawning areas disturbed, as may wildfowl nesting sites in marginal areas. Rubbish and trash left behind by participants may also be harmful to animals; fishing lines, hooks and weights are well known examples that may cause death or injury to aquatic birds or mammals.

Angling exerts a predatory effect on fish and as such may act to distort the natural food chain within surface waters. Where fish catches are small this is unlikely to comprise a significant impact but where angling is intensive impacts may arise. Fish stocking of controlled waters for angling purposes may modify a natural fish community and live baiting may introduce exotic species to an inland water body, to the detriment of a native species. Bait digging may cause localised disruption to shoreline wildlife communities.

### 5.2.5 Terrestrial ecology

**Facilities**
Alteration of surface water and riparian or shoreline drainage due to the presence of covered areas of land may cause a change in the soil moisture content of adjacent terrestrial habitats, with a consequent impact on the local flora and fauna. The erection of structures and/or fences in marginal, riparian or shoreline areas may inhibit the

movement of terrestrial mammals.

**Activities**
Walking, angling, bird-watching and canoeing may result in trampling of riparian habitats and cause destruction of vegetation and temporary disturbance of wildlife; this may be of particular concern in sensitive areas which have a high conservation value.

### 5.2.6 Human-related

**Facilities**
Facilities associated with water-based recreation may inhibit free access to inland or coastal waters. This may cause disruption to other users of the water environment. Such structures may also cause an adverse visual impact to the landscape, particularly where they are situated within an area of scenic interest.

**Activities**
Polluting discharges or the disposal of litter to surface waters during recreational activities may cause adverse visual impacts to the water environment. For some interested parties, perhaps local residents, water-based recreational activity itself may be thought to exert an adverse visual impact on the natural landscape.

Noise from motor powered boats and other equipment, such as jet-skis, may have a very significant adverse impact on the local community, other users of the water environment and those pursuing leisure activities on adjacent land.

Conflicts of interest may arise between users of the water environment who are engaged in non-compatible activities. Conflict between the needs of canoeists and anglers, for example, is considered a major issue by some, particularly on salmonid rivers.

Where access is facilitated for the purpose of water-based recreation, recreational activities may result in claims of trespass/negligence/nuisance by or against neighbouring land or riparian/shoreline owners

## 6. Mitigation measures

The most effective mitigation measures for impacts likely to be caused by water-based recreation are those which are incorporated into the design of recreational developments and into an acknowledged code of practice for all participants. These are presented here under headings of recreational developments and activities. The good practice guides published by The Sports Council (SC & CC, 1995; Sidonay, 1991) are also relevant.

### 6.1 Developments

- New moderate or large sized developments intended to support water-based recreation should be situated, if possible, in riparian or shoreline areas of low conservation and landscape interest. Derelict land or land of low amenity value might be used for leisure developments (House of Commons, 1995).
- Recreation developments should be sited to minimise conflict with other water-based recreational activities and with other users of the water environment.

- Recreation developments likely to produce noise, such as a jet ski, water ski or powerboat support facilities should be situated at least 500 metres from any noise-sensitive premises.
- Recreation developments should adopt a design sensitive to, and in character with, the surrounding natural environment.
- The design and construction of all recreational developments should follow the appropriate NRA Pollution Prevention Guidelines (see references).
- All boat service areas should have an oil separator installed on the surface water drainage system. This should be regularly inspected and cleaned as required. A Guidance note on oil separators is available from the NRA (see references).
- Adequate provision should be made for oil and fuel storage where this will occur. An impervious base should be created within an oil-tight bund for oil/fuel tanks and drums. There should be no drainage outlet. Guidance notes on the storage and disposal of oil and fuel are available from the NRA (see references).
- Where rainwater runoff from vehicle parks is drained to a river or other water body, the drainage system should be designed to release water slowly after heavy storms. Outlets into surface waters should be placed to minimise erosion of bed and banks and to reduce the velocity of discharge.
- Vehicle parks and yards should drain first to an oil separator if pollutants are likely to exist in the runoff.
- A recreation support facility should be drained to the public foul sewer wherever feasible, although it is recognised that this may not be possible in remote areas. An alternative is to drain sewage and other contaminated water to a sealed tank so that no discharge to controlled waters takes place.
- Where a septic tank or package sewage treatment system is used, all facilities, including drainage fields, should be constructed and installed to the specifications provided by BS 6297. A percolation test should be conducted to ensure effective operation of any drainage field. The NRA has produced guidelines relating to sewage disposal where no mains drainage is available (see references).

### 6.2 Recreational activities

- The use of motor powered vessels on inland waters should follow the NRA Pollution Prevention Guidelines: *Inland Waterways: Marinas and Craft.*
- Storage and disposal of oil and fuel should follow the appropriate NRA Pollution Prevention Guidelines (see references).
- Recreational activities such as water skiing and jet skiing may not be compatible with the riverine environment nor with other river or riverbank users. These activities should be confined to coastal waters or large lakes.
- In surface waters where bank or shore erosion may present a threat to terrestrial and aquatic habitats or bank/shore stability, restrictions on boat use should be considered. A decrease in boat speed and frequency of passage can dramatically reduce river bank erosion (Nanson *et al*, 1994).
- Noise emitted by motor powered boats may be reduced by the introduction of speed limits, use of LPG fuelled engines, regular maintenance of engines and fitting of adequate silencers.
- Riparian sites used regularly by bird-watching, angling, or canoeing clubs/societies should be treated with care by users and, where possible, should be provided with adequate footpaths and water access facilities. This may involve negotiation and agreement with riparian owners.
- Recreational users of the water environment should follow appropriate environmental guidance provided by the NRA, the Sports Council, or a relevant sporting/recreational organisation such as the British Canoe Union, National Federation of Anglers, British Water Ski Federation or the Personal Watercraft Association.
- Recreational users of inland or coastal waters should make every effort to protect aquatic wildlife, aquatic habitats and the surrounding landscape.
- Recreational users of the water environment should have respect for the needs and desires of others, including residents and other users.

## 7. Baseline surveys

Where a development proposal is designed for the purpose of providing facilities or support for water-based recreation activities, the baseline information required for an EA will depend on the type of development proposed, its location and the recreational activity that will be supported. This may include data obtained from:

- River Corridor survey (NRA, 1992).
- Geomorphological survey to identify riparian or shoreline areas vulnerable to wave-induced erosion.
- Habitat survey.
- Survey of recreation and fisheries activity within adjacent inland or coastal waters.

## 8. Monitoring and Audit

Where appropriate, a post-project audit may be used to confirm the predicted impacts of a new water-based recreational development on water quality, the landscape and adjacent terrestrial habitats. In addition, a monitoring strategy should be designed and implemented to observe the effect of recreational activity on the water environment over a period of time. Bank or shoreline erosion should be monitored, as should the flora and fauna of aquatic and riparian habitats. Such information may be used to initiate retrospective mitigation measures should unexpected impacts occur.

## 9. References and guidance

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**Pollution Prevention Guidelines**

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- Pollution Prevention Guidelines 2: *Above Ground Oil Storage Tanks.* NRA, Bristol.
- Pollution Prevention Guidelines 3: *The Use and Design of Oil Separators in Surface Water Drainage Systems.* NRA, Bristol.
- Pollution Prevention Guidelines 4: *Disposal of Sewage where No Mains Drainage is Available.* NRA, Bristol.
- Pollution Prevention Guidelines 5: *Works in, Near or Liable to Affect Watercourses.* NRA, Bristol.
- Pollution Prevention Guidelines 6: *Working at Demolition or Construction Sites.* NRA, Bristol.
- Pollution Prevention Guidelines 8: *Safe Storage and Disposal of Used Oils.* NRA, Bristol.
- Pollution Prevention Guidelines 14: *Inland Waterways: Marinas and Craft.* NRA, Bristol.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF OFF ROAD RECREATION ACTIVITIES

## 1. Introduction

This guidance note seeks to identify the impact of off-road recreation activities on the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of these pastimes. The NRA has an interest in off-road recreation activities owing to its general environmental responsibilities, particularly with respect to the protection of the water environment. The Act also lays down a general duty for the NRA to promote the recreational use of inland and coastal waters and associated land.

Off-road recreation activities as described in this guidance note include the use of two or four-wheel drive vehicles, motorcycles and mountain bikes on any land that is not a surfaced public highway. It also includes horse riding away from bridleways, as many of the impacts caused by this pastime are similar to those associated with motorised vehicles and mountain bikes. This guidance does not encompass motorised sports conducted on a permanent course.

It is intended this guidance note assist landowners who wish to develop their property for use in off-road recreation, and clubs or societies engaged in such pursuits to organise or enjoy such activities while minimising impacts on the water environment.

## 2. Development control

Off-road recreation activities that take place on public rights of way are not subject to development control consenting procedures, although if any supporting facilities were to be constructed they would fall under the Town and Country planning system. This is unlikely to occur due to the mobile nature of these types of recreation.

Where an area of land previously used for agriculture or forestry is converted to a semi-permanent track for off-road recreation vehicles, planning permission may be required for such change of use. The requirement for development consent may depend on the number of days each year the land will be used for off-road recreation and prospective developers should consult with their local planning authority.

Bylaws governing access to and use of unsurfaced carriageways in the countryside (Green Lanes and Byways) are implemented by local highway authorities, who are also responsible for the classification of routes. Some tracks were denoted as 'Roads Used as a Public Path' under the National Parks and Access to the Countryside Act 1949. These are to be reclassified either as 'Byways Open to All Traffic', which are, as the name implies, open to cars as well as horses, cycles and walkers, or as bridleways, which are not open to cars. Problems have arisen with this reclassification and the process now hinges on the demonstration of vehicular rights over history for a certain stretch of path. As of 1990/91, 6,000km of Roads Used as Public Paths still existed in England and Wales (House of Commons, 1995).

## 3. Environmental Assessment

No developments likely to be associated with off-road recreation activities are identified in the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) as requiring formal Environmental Assessment (EA). Nevertheless, a local planning authority or highway authority may request certain information where an application is made for change of use of land to recreational purposes or reclassification of unsurfaced carriageways. This may be necessary in areas of high conservation value or where conflicts with other recreational activities or forms of land use are likely to arise. An EA may provide the most appropriate method by which relevant environmental information can be collated.

Guidelines prepared by the Department of the Environment (DoE, 1995) describe the conduct of an EA and preparation of a formal report. These should also prove relevant for less formal assessments.

## 4. NRA consents/licences

No NRA consents or licences are applicable to off-road recreation activities. However, where the development on private land of a semi-permanent off-road route involves the erection of any structure in, over or under a watercourse, NRA consent will be required under either the Water Resources Act 1991 or the Land Drainage Act 1991.

## 5. Major potential impacts

The primary issues of concern for the NRA in relation to off-road recreation are the potential impacts of these activities on environmental components within river channels, river corridors and/or within the coastal zone.

### 5.1 Geomorphology

The repeated passage of motorised vehicles along unsurfaced Green Lanes, Byways or any semi-permanent route on private land is likely to result in considerable erosion of the land surface. This can be intensified by rainfall which may result in further erosion particularly on sloping ground, and cause puddling of the ground. Severe erosion and irreparable damage has been noted on some tracks used by motorised vehicles (House of Commons, 1995). Even mountain bikes and horses may cause extensive erosion and degradation of footpaths, bridleways or tracks where they are used. This is most likely to occur where tracks are traversed repeatedly in wet conditions.

The formation of gullies and puddling of ground surface by the passage of recreational vehicles or horses is likely to decrease percolation of water into the soil and increase surface water flows. Where this surface water runs directly to a watercourse, it may cause localised erosion of a stream bed or banks.

Where motorised vehicles, mountain bikes or horses cross a watercourse, significant erosion of stream bed and banks may occur, along with considerable disturbance of sediments. It is possible that erosion by vehicles or horses may de-stabilise flood embankments where these are subject to repeated passage, as these embankments are generally not designed for use in off-road recreation activities. This may be of particular concern where steep flood embankments close to a watercourse are repeatedly traversed. The eroded material from stream bed or banks that is brought into suspension will be deposited downstream and the natural pattern of sediment distribution within a channel may be changed.

Where off-road recreation activities take place within the coastal zone, the use of motorised vehicles, bicycles or horses may cause erosion of sand dunes or sea defence structures. The repeated passage of vehicles or horses may result in the destruction of vegetation such as marram grass, that acts to bind the surface of dunes, or the grass covering of flood embankments. Where this protection is lost the stability of dunes or sea defences may be at risk from gully formation and erosion by the action of wind and water.

Potentially irreversible damage to the geomorphological structure of coastal shingle formations may be caused by the passage of off-road vehicles and trail bikes (House of Commons, 1995).

## 5.2 Hydrology/Water quality

Erosion of unsurfaced tracks by vehicles, mountain bikes or horses may significantly alter surface water drainage. An increase in the intensity of local flooding is likely in periods of high rainfall due to the rapid runoff of surface water from eroded tracks. This may cause significant additional stream bed and bank erosion.

Erosion of trackways, stream bed and banks likely to be associated with the passage of recreational vehicles or horses may cause increased water turbidity and sediment load of any adjacent watercourse.

The repeated passage of motor vehicles through a watercourse may also cause chemical pollution from oil and fuel. Although such pollution may be relatively minor and localised, it may nevertheless represent a significant impact on water quality in small streams within remote areas.

## 5.3 Aquatic ecology

Where vehicles or horses regularly cross a stream channel, destruction or disruption of benthic and marginal communities may occur. Downstream, a change in water quality due to increased turbidity and/or chemical or organic pollution may exert an adverse impact on aquatic flora and fauna.

Increased intensity of flood events due to changed surface runoff may also alter the aquatic community of a watercourse. Erosion and downstream siltation resulting from the passage of motor vehicles or horses may cause change to the species composition of the benthos. Erosion is likely to inhibit the presence of benthic algae and invertebrates, while downstream siltation may allow only those animals adapted to living in mud and silt to remain.

Where off-road recreation takes place within the coastal zone, destruction or disturbance of salt marsh, beach sand, shingle or grazing marsh habitats may occur. The type and intensity of impact will depend on the form of off-road recreation involved and the sensitivity of the aquatic environment concerned. In general, some loss of surface vegetation may be expected and physical disturbance of the feeding or breeding habitats of invertebrates, mammals and birds is likely to occur.

The noise generated by off-road recreation vehicles may cause temporary and localised disturbance to nesting or breeding sites of wildfowl (Tuite, 1983).

## 5.4 Terrestrial ecology

Where off-road recreation vehicles are used away from recognised Green Lanes or Byways, they may cause destruction or disturbance of riparian and terrestrial habitats. Vegetation may be crushed and soil structure altered by the weight of such vehicles. The passage of horses over land not designated as a bridleway may cause similar habitat destruction.

In the coastal zone, off-road recreation may damage the sand dune environment. In addition to the value of sand dunes as wildlife habitats, particularly for birds, the destruction of vegetation on these formations may have serious implications for dune stability and flood defences, as indicated in an earlier section.

Engine noise from motorised vehicles may disturb birds and/or mammals whose territorial boundaries encompass an off-road route. The feeding range of such wildlife may be modified as a result.

## 5.5 Landscape

The presence of off road recreation vehicles may represent an adverse visual impact in an area that has scenic value. Any rubbish or trash left by participants in off-road recreation will also be detrimental to landscape character.

The noise from off-road vehicles is likely to disturb the tranquillity of a landscape. This may comprise a very significant impact as a loss of tranquil areas in recent years has been noted nationally (CPRE, 1995).

## 5.6 Human beings

Off-road recreation motor vehicles, mountain bikes and horses may cause disruption and distress to other users of the countryside and coastal zone.

Where vehicles and/or horses use tracks or footpaths commonly used by ramblers, the muddy ruts and pools of water resulting from their passage may cause disruption to pedestrians. Such conditions may create grave access problems for wheelchair users and detract from their enjoyment of the countryside. Such conflicts of interest concerning rights of way should be addressed in any EA.

The impacts of off-road recreation on water quality and aquatic ecology may cause disruption to other users of the water environment, such as anglers or bird-watchers.

The noise, dust, fumes and mud that may be produced by some off-road recreation activities are likely to be a nuisance to nearby residents and visitors to the countryside and coastal zone.

## 6. Mitigation measures

The appropriate siting of off-road vehicle routes represents the most effective form of mitigation for many of the impacts caused by this form of recreation. The classification or re-classification of Green Lanes and Byways and their maintenance are responsibilities of the local highway authorities. The use of private land for off-road recreational activities may require consent from a local planning authority.

In order to protect the water environment from the impacts of off-road motor vehicles it is preferable that:

- Green Lanes, Byways and private land are not used by motorised vehicles where they would pass through or adjacent to surface waters, aquatic habitats or areas within the coastal zone with a high conservation value.
- Sections of public unsurfaced highways likely to suffer substantial erosion from off-road recreation activities, such as steep slopes and boggy ground, are not used for this purpose.
- Tracks designated for use by motorised vehicles should be adequately maintained by highway authorities, particularly with regard to land drainage.

Protection of surface waters and natural features may be necessary in some areas. For example, where off-road recreation routes cross water channels vulnerable to erosion it may be necessary to erect some form of protective structure over the stream bed and banks. This could take the form of stone ramps or log bridges. Similar repair or preventative works may be required on heavily eroded slopes used by off-road vehicles or horses. It is possible that volunteers from conservation and off-road recreation groups could undertake such work on public rights of way, as members of the Land Access and Recreation Association currently do (House of Commons, 1995). The NRA is able to provide advice to any developer or voluntary group as to how the water environment may be protected against potential damage from off-road recreation.

Where users of off-road recreation vehicles wish to traverse water or boggy ground as part of their activities, it is preferable that artificial wetland areas are constructed for this purpose in order to protect natural watercourses and wetlands. Drivers should also ensure that adequate silencers are used for their engines.

Drivers of vehicles and mountain bikes on Green Lanes or Byways should follow a code of conduct, such as that prepared by the Trial Riders Fellowship (TRF, 1981) to:

- Use only vehicular rights of way.
- Keep to defined routes across farmland.
- Give way to walkers, horses and cyclists.
- Fasten all gates.
- Travel at a safe speed (25 mph maximum).
- Ride or drive as quietly as possible.

All those engaged in off-road recreation should heed the advice or code of conduct of their respective governing body, where one exists, with respect to reducing the environmental impact of their activities. Organisations such as the British Mountain Bike Federation, British Cyclo-Cross Association, British Horse Society and the Motoring Associations' Land Access and Recreation Association are usually able to provide such advice.

It is difficult to mitigate against the environmental impacts caused by off-road vehicles or mountain bikes that do not use appropriate tracks or private land. The erection of barriers on footpaths may prevent larger vehicles from passing, but is unlikely to obstruct motorcycles, mountain bikes or horses. Environmental education could prove effective in reducing the use of footpaths in this way, with on-site notices likely to be most effective.

## 7. Baseline surveys

In order to assess the likely environmental impact on the water environment of existing or proposed off-road recreation routes, the following information would be required:

- Geomorphological survey of watercourses and adjacent landto identify areas at risk of erosion.
- River corridor survey (NRA, 1992) to identify habitats, species and features of special conservation interest within aquatic and riparian environments.

## 8. Monitoring

Regular inspections of any semi-permanent private track used for off-road recreation activities should be undertaken. This will enable sections of the course suffering surface erosion to be identified so that mitigation measures may be employed.

Local or highways authorities may be in a position to survey existing public off-road routes and identify problems when they occur. Perhaps the most effective form of monitoring however comes from those members of the public who regularly use Green Lanes, Byways, bridleways and footpaths, who should be encouraged to report erosion or habitat destruction when this is seen to occur.

## 9. References and guidance

Council for the Protection of Rural England (1995) Tranquil Area Maps. CPRE Publications, London.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

House of Commons - Environment Committee (1995) *The Environmental Impact of Leisure Activities.* HMSO, London.

National Rivers Authority (1992) *River Corridor Surveys: Methods and Procedures.* Conservation Technical Handbook No. 1, NRA, Bristol.

Trail Riders Fellowship (1981) *Code of Conduct for Green Lane Use.*

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF VEGETATION MANAGEMENT

## 1. Introduction

This guidance note seeks to identify the potential impacts of vegetation management upon the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such activities. The NRA has an interest in vegetation management in or adjacent to surface waters due to its statutory responsibility for the protection of the water environment under the Water Resources Act 1991 (WRA). The Act also imposes a general duty on the NRA to promote conservation and enhancement of the natural beauty and amenity of inland waters and associated land. This duty also applies in respect of its own proposals and activities.

This guidance note examines the potential environmental impacts of vegetation management for riverbanks and river channels. It should also prove applicable for Environmental Assessment (EA) of vegetation management activities within or adjacent to any controlled waters, including lakes and canals. It is appropriate for use by developers, where vegetation management comprises part of a development proposal, riparian owners and drainage authorities.

A wide variety of options are available for riverine vegetation management and the precise nature of operations will depend on local conditions and the rationale for action. Riparian vegetation management may take the form of habitat enhancement by selective cutting of trees, shrubs or grasses, protection from grazing or damage, or creation of vegetated areas by planting with indigenous species. Alternatively, it may comprise vegetation control by mowing, cutting or grazing of existing vegetation, or the use of herbicides. Similarly, aquatic vegetation management may involve the encouragement of wetland areas as new habitats or the control of weeds by mechanical, chemical or biological means. The NRA is able to offer advice on the most suitable type of vegetation management to any party that needs to undertake such action.

Vegetation control by the introduction of species, for example Grass Carp for aquatic weed control (NRA, 1992a) is not examined here. The deliberate introduction of species is discussed in Guidance Note 46. of this series.

It is NRA policy that, when vegetation control is necessary in or adjacent to water, this should be undertaken by non-chemical methods wherever possible. Only if this is not suitable or practicable in a given situation should herbicides be used (NRA, 1995a).

## 2. Development control

Vegetation management itself does not fall under the Town and Country Planning system and planning permission is not required. However, where vegetation management comprises part of a new development proposal it may be a material consideration in any application for development consent.

## 3. Environmental Assessment

Vegetation management is not identified in the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) as requiring EA. However, where such works are an integral part of a larger development that falls under these Regulations, the impact of a vegetation management plan should be addressed in an EA of the development proposal.

Some types of vegetation management may fall within the category of land drainage improvement for regulatory purposes. The Land Drainage Improvement Works (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1217) (as amended) lay down a procedural requirement to be followed by any statutory drainage authority in respect of such works. This specifies an EA should be conducted where the proposed works are likely to have significant effects on the environment by reason of their nature, size or location. It is for the drainage authority to determine if an EA is warranted. The drainage body must give notice in the local press of any land drainage improvement works, including vegetation management schemes where applicable, with a statement as to whether or not an EA will be carried out for the proposed project.

Whether or not proposed vegetation management requires a formal EA as part of a larger development or as land drainage improvement, an EA of such proposals can determine the potential impact of these activities upon the water environment in advance of operations. Such action will assist the NRA in discharging its statutory responsibilities for land drainage, flood defence, fisheries and the conservation and enhancement of the water environment. It may also prevent a developer or operator from unintentionally causing harm to surface waters that may result in an offence under the WRA.

It is recommended that the conduct of an EA and subsequent preparation of a formal or informal report should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

Consent from the NRA is required before a herbicide can be used in or near water. If permission is granted the onus is on the herbicide user to ensure that the interests of other water users are not adversely affected. Herbicide users should inform abstraction licence holders, relevant conservation bodies, riparian owners and occupiers of their intentions.

Certain types of vegetation management may require Land Drainage Consent from the NRA under the WRA. The Act is applicable to vegetation management that may affect water flow within a channel or floodplain.

## 5. Major potential impacts

Potential impacts of vegetation management for the water environment are described here under headings for each major operational activity. Riparian and aquatic vegetation management impacts are dealt with separately.

Vegetation management will bring beneficial impacts for the issues it is undertaken to address. This may be the protection of existing flood defences, weed destruction, improvement of bank stability, habitat creation or visual amenity. This guidance note concentrates primarily upon the potential adverse impacts of vegetation management on surface waters, as most positive impacts will be inherent in the management strategy.

## 5.1 Riparian vegetation management

Management of riparian vegetation may be undertaken for a variety of reasons including:

- the control of natural succession;
- to suppress undesirable species;
- for habitat creation or enhancement;
- the encouragement of specific species or habitat structure;
- to minimise channel and floodplain roughness;
- to aid structural stability of embankments;
- for aesthetic reasons.

### 5.1.1 Shrub/grass control

Control of shrubs or grasses can be undertaken by mechanical methods such as mowing, strimming or cutting, or by the use of herbicides. Each has potential impacts for the riparian and aquatic environment.

**Mechanical control**
Mowing or cutting of vegetation can dramatically alter a riparian habitat. Shelter, feeding resources and breeding areas for invertebrates such as butterflies, vertebrates, birds and water-fowl may be partially or completely destroyed. Clear cutting of riparian vegetation may increase local surface runoff and result in bank erosion and increased the extent of flooding.

Cutting of some invasive species such as Japanese Knotweed, Giant Hogweed and Himalayan Balsam may be necessary at two-weekly intervals throughout the growing season for ten years in order to remove them (NRA, 1994). However, the benefit of such an extreme method to control invasive plants may be rather dubious as fragments as small as 2cm of Japanese Knotweed are sufficient for propagation. Where this form of control is used, it is likely to cause considerable physical disturbance to habitats along any access route and around the working area. Significant disturbance to mammals and nesting wildfowl may be expected and the return of such wildlife after a lengthy period of disruption is likely to be slow.

Disposal of riparian vegetation cuttings is likely to cause some adverse impact. If they are dumped into a watercourse they may act as a physical obstruction to water flow and also, in decomposition, cause de-oxygenation of surface waters. Increased nutrients released from decaying plants could trigger algal blooms in some water bodies. These are likely to have an adverse effect on water quality. If vegetation cuttings are left *in situ*, they may suppress floral diversity by encouraging rank species. Also, surface water runoff may carry decomposing material to a watercourse with consequent enrichment and de-oxygenation of surface waters as just described. If vegetation cuttings are burnt this may cause air pollution, nuisance to human being and localised destruction of species and habitat.

**Chemical control**
If a herbicide is used carelessly or as an indiscriminate spray it may kill all riparian vegetation within the working area, including rare species, those of value as a wildlife food or nesting resource and those acting to stabilise a riverbank or shore. Leakage, spillage and careless disposal of empty containers may also cause harm to riparian vegetation and, if herbicide should enter surface waters, to the aquatic environment.

Where rain falls shortly after herbicide is applied a large proportion of the chemical may be washed to a watercourse and destroy aquatic plants. This could result in a deterioration of water quality due to decay of dead vegetation, including de-oxygenation, which may prove harmful to invertebrates and fish.

### 5.1.2 Tree removal/pollarding/coppicing

Removal, felling or partial cutting of trees is likely to require the use of machinery which may cause destruction of riparian habitat along the line of access and around the working site. Compaction of soil may occur which may inhibit riparian drainage and cause bank erosion; this may result in subsequent deposition of material within a river channel. Also, where tracking across a watercourse occurs, this can damage channel features and disturb sediments. This would be of particular concern where fish spawning areas exist as it is illegal to disturb these under the 1975 Salmon and Freshwater Fisheries Act.

Tree removal or felling will result in loss of habitat for invertebrates, mammals and birds. Pollarding or coppicing is also likely to cause habitat loss in the short-term, although eventually this may result in an increased habitat diversity. Both these actions are likely to lead to a reduction of shade on a watercourse that may cause an enlarged growth of aquatic vegetation and increased river water temperature.

## 5.2 Aquatic vegetation management

Aquatic vegetation includes bankside, emergent, floating and submerged plants, and also algae. Their management may be necessary to:
• remove obstruction to flow;
• reduce siltation within weed beds;
• improve water quality;
• reduce blockage of pumps and sluices;
• increase safety of a channel for livestock and recreation.

Aquatic vegetation management is most likely to be necessary in slow flowing lowland rivers as the high level of nutrients and soft substrata often found in such channels act to encourage plant growth. The most common forms of vegetation control are by mechanical or chemical methods. Biological control, such as grazing by cattle or sheep, may also have some limited application in certain situations.

### 5.2.1 Mechanical control

Aquatic weeds may be controlled by cutting, dredging or raking. Cutting and raking are most suitable for floating or submerged plants and algae. Dredging may be used where it is necessary to uproot emergent or submerged plants.

**Cutting/raking**
Depending on the depth of water, weed cutting may be undertaken by hand, from a boat or with the use of a weed-cutting bucket. All these methods are likely to disturb channel sediments and temporarily increase water turbidity, although to a lesser extent than would dredging. Hand cutting of marginal weeds is likely to disturb sediments and increase turbidity to a large extent.

Unless a weed cutting bucket is used to collect cut material, cut weeds may float downstream potentially causing blockages to bridges and culverts. As the dead vegetation decomposes, nutrient enrichment and de-oxygenation of water may occur.

Cutting of vegetation may reduce the extent of the natural habitat of a wide variety of aquatic life including invertebrates such as insects and snails, amphibians like frogs, toads and newts, small mammals and birds. The timing of a vegetation cut will influence the intensity of impact on wildlife.

Weed cutting or raking is likely to increase water flow within a channel which may cause localised bed or bank erosion and transportation of sediments downstream. This is most likely to occur where all vegetation within a channel is cleared. This impact can be short-lived as re-growth of vegetation may be rapid.

Where vegetation cutting is undertaken at freshwater margins the toxicity of some plants when cut and wilting may present a danger to herbivorous animals. Cowbane (*Cicuta virosa*), Yellow Flag (*Iris pseudacorus*) and Hemlock Water-Dropwort (*Oenanthe crocata*) are examples of poisonous vegetation. Where livestock have access to such plant cuttings, mortalities may occur.

**Dredging**
Dredging will remove the top layer of river bed, including roots and rhizomes of aquatic vegetation. Such action may therefore denude a section of river channel of rooted and emergent plants. This may represent complete destruction of habitat for many animal communities. Dredging will also remove all invertebrates that live on or in the river bed and a river channel may be practically devoid of aquatic wildlife for some time after such disturbance.

Dredging is likely to cause considerable disturbance of sediments with a consequent large increase in water turbidity and transportation of material downstream. Increased turbidity may reduce photosynthesis of submerged plants through light attenuation (Tobiessen *et al*, 1992) and thus oxygenation of the water. Increased turbidity may also alter the migratory behaviour of fish. Transportation of sediments may disturb the existing pool/riffle sequence. Downstream areas may become silted and smothering of existing benthic or marginal communities may occur.

Potential impacts of dredging activities on the water environment are described further in Note 31 of this series (Channel Works - including fluvial dredging).

### 5.2.2 Chemical control

The direct application of herbicides to the water environment may contaminate water abstracted for public supply or agricultural irrigation. Any such contamination would represent a risk to human health and could also damage agricultural crops.

When herbicides are used in water, plant photosynthesis may be inhibited directly by the chemical used or by the light attenuation effect of organic decomposition detritus. This may cause de-oxygenation of water that, combined with eutrophication caused by sudden nutrient release from a large volume of decaying vegetation, could result in a dramatic decline in water quality. Disturbance or death of invertebrate and fish populations may result.

If herbicides are sprayed on emergent and floating weeds over a large area of water all vegetation may be destroyed. This may disrupt local food chains and cause loss of shelter, feeding and breeding areas for invertebrates, fish fry and wildfowl. The timing of herbicide application will influence the intensity of impact upon wildlife as most, although not all, fish, birds and insects reproduce in the spring months. Herbicide application during this time could have a major adverse impact on the population of some species and may disrupt community composition.

Poisonous plants such as Hemlock Water-Dropwort or Ragwort are normally avoided by livestock but may become more palatable after spraying with herbicide yet still remain toxic. Where livestock have access to any vegetation treated with herbicide injury to the animals may result.

Herbicide spillage, leakage or careless disposal of containers could all pose a threat to the aquatic environment.

## 6. Mitigation measures

A comprehensive guide to vegetation management practices that may cause least impact to the water environment or that may benefit wildlife is provided by *The New Rivers and Wildlife Handbook* (RSPB *et al*, 1994). A review of current aquatic weed control practice has been undertaken (NRA, 1993) and best practice guidelines produced (NRA, 1995).

Possible mitigation measures are presented here separately for riparian and aquatic vegetation management.

### 6.1 Riparian vegetation management

- Where riparian vegetation is established, perhaps to help mitigate the impacts of a riverside development or to stabilise flood defence works, planting and management should follow the guidelines suggested by the *New Rivers and Wildlife Handbook* (RSPB *et al*, 1994).

- Livestock grazing should be used where possible to control bankside vegetation as this may benefit wildlife conservation and flood defence. However, this form of vegetation management is not appropriate in areas where livestock may contribute to bank erosion or reduce habitat regeneration by grazing of saplings. Timing, intensity and the choice of livestock are important factors in this form of control and are discussed in *The New Rivers and Wildlife Handbook.*
- Tree surgery should be carried out with the assistance of a qualified arboreculturalist.
- Where mowing is used for vegetation management a balance should be found between the need for an early grass cut to meet flood defence criteria and a later cut to minimise disturbance of animals in their breeding season. Autumn mowing is recommended.
- A 'blanket cut' of riparian vegetation should be avoided. Patch cutting on a rotation can improve plant diversity and habitat structure. A minimum of 10% should be left uncut and it is preferable that strips of uncut vegetation are retained from the waterside upwards through the riparian area. In rotation of vegetation cutting, no patch should be left uncut for more than three years to prevent rank grasses, nettles and scrub dominating an area.
- It is preferable that vegetation cuttings are not burnt or left on site. If possible they should be collected and either taken to a registered waste disposal facility or composted on sites of low conservation interest where liquid from decomposition cannot enter the river. However, it is recognised that the costs of collection and transport of vegetation cuttings may be prohibitive in some instances. Where this is the case, cuttings should be collected in small heaps as far from the water as possible. They may either be left there to decompose or burnt. Burning of cuttings must be closely supervised to ensure a fire does not spread out of control.
- Herbicides are suitable for vegetation control near water only when no other means is practicable. Only those approved by the Ministry of Agriculture Fisheries & Food should be used. The use, storage and disposal of herbicides and their containers should be in accordance with Regulations governing pesticides (see references) and *The Use of Herbicides in or Near Water* (NRA, 1995b).
- Herbicides must never be sprayed indiscriminately over riparian land. Directed spraying or treatment such as wiping or spotting of unwanted species should be undertaken. Herbicide application must only be carried out by operatives who hold a certificate of competence issued by the National Proficiency Tests Council.

### 6.2 Aquatic vegetation management

- Where aquatic vegetation is established to assist riverbank protection or as habitat enhancement, management this should follow the guidelines suggested by the *New Rivers and Wildlife Handbook* (RSPB *et al*, 1994).
- Where aquatic weeds are controlled by cutting or raking, the remains must be collected and removed from the water. Large quantities may be taken to a waste disposal facility or composted as described above. Where this is not possible they should be collected in small heaps away from the water environment and either left to decompose or burnt.
- Cutting of aquatic vegetation should be timed to minimise disturbance to invertebrates and other wildlife. As a general rule, submerged plants should be cut in summer and emergents in the autumn (RSPB *et al*, 1994).
- Some aquatic vegetation should always be retained *in situ* so that uniform structure and synchronised re-growth are avoided.
- Even where regular and extensive weed cutting is required, some patches of vegetation

should be retained to safeguard rare species and plant communities. This may be achieved by alternating cutting from either bank and leaving one-third of a channel untouched.

- Where dredging is used as a form of vegetation management, this should not be undertaken along continuous lengths and complete widths of a channel. Parts should be left undisturbed so invertebrate communities may recover fairly rapidly. It is preferable that alternate lengths are de-silted to allow speedy recolonisation by plants and animals. Alternatively, strips of vegetation along one or both sides of a channel may be left untouched and dredging undertaken through the centre only.
- Dredging should be undertaken in an upstream direction so plant roots and animals released during excavation can drift and re-colonise sections already completed.
- Patches of vegetation should be left on channel margins, or in mid-stream. These can act as refuges from which recolonisation can occur. Rare plants should be avoided where possible.
- Downstream siltation caused by dredging may be minimised by construction of a temporary silt and sediment trap.
- Spoil from river dredging may have commercial value as an aggregate or fertiliser and it should be disposed of in this manner where possible.
- Herbicides should be used for vegetation control in water only if no other means of control is practicable. They must be approved for use in water by the Ministry of Agriculture Fisheries & Food. The use, storage and disposal of herbicides and their containers must follow the guidance given in the previous section.
- The NRA must be consulted prior to herbicide use as this may be inappropriate in some locations.
- The timing of herbicide application should follow the product specification. Mid- to late summer spraying of emergents and floating weeds is appropriate as the chemical acts through leave and stem area. Most birds and invertebrates have completed their reproductive cycle by this time and should not be disturbed by the treatment. Submerged weeds and algae should be treated in the spring or early summer as they are more susceptible to herbicide when young. The risk of de-oxygenation is reduced at this time as the water is relatively cold, contains high levels of dissolved oxygen and the potential quantity of decaying plant material is small.
- When herbicides must be used in the summer months, localised application only should be undertaken.

## 7. Baseline surveys

A comprehensive survey of habitats, flora and fauna will be necessary baseline information required for an EA of vegetation management. This should take the form of a standard river corridor survey (NRA, 1992b) that includes the aquatic, marginal, bank and floodplain zones. A river habitat survey may need to be undertaken in restricted geographical locations of interest. These surveys should identify any plants listed as protected under Schedule 4 of the 1994 Wildlife and Countryside (Natural Habitats etc.) Act (SI Nº 2716).

A detailed botanical survey should be undertaken as part of any vegetation management plan and used in EA; this will reveal the presence of rare species and will assist management planning. A qualitative invertebrate survey of marginal and aquatic environments may be required where rare species are thought to be present and in some cases a geomorphological survey of sediment distribution may be necessary.

## 8. Monitoring

On-site supervision of working practice by an environmental specialist should be arranged, particularly if sensitive habitats or species are present.

An appropriate monitoring strategy should be developed to confirm the predicted impacts of the works on water quality, water flow, sediment distribution and the flora and fauna of aquatic and riparian habitats. The effectiveness of mitigation measures should also be assessed. Periodic monitoring surveys should be undertaken to evaluate the establishment of new vegetation and recovery of riparian and aquatic habitats. The timing and frequency of monitoring surveys will depend on the type of vegetation management plan enacted.

## 9. References and guidance

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

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### Regulations

The Control of Pesticides Regulations (SI 1986 Nº 1510)

The Control of Substances Hazardous to Health Regulations (SI 1988 Nº 1657)

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF THE DELIBERATE INTRODUCTION OF SPECIES

### 1. Introduction

This guidance note seeks to identify potential impacts on the water environment of the deliberate introduction of species. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such action. It will assist any individual or organisation who propose to introduce exotic species to the water environment, to identify the potential consequences that may occur and possible mitigation measures that can be taken to avoid these impacts. The NRA has an interest in deliberate introduction of species to the water environment due to its statutory environmental responsibilities under the Water Resources Act 1991.

Plant or animal species can be introduced deliberately into controlled waters (rivers, lakes, canals etc.) to develop harvestable resources, provide prey for other species or to modify habitats. The use of grass carp as a means of weed control is a common method of habitat modification. Introductions may also be made to restore lost native species, such as otters and salmon, as a conservation initiative, or to provide wider sporting opportunities, as illustrated by the introduction of rainbow trout and wels catfish.

While introduced species may provide various benefits, unanticipated impacts can cause serious social and ecological damage (Westman, 1990). In the UK, the spread of zander after their deliberate release into the Great Ouse Relief Channel in 1963 has exerted a new predation pressure on native fish in central and eastern England. Plants such as Japanese Knotweed and Giant Hogweed, although not introduced directly or deliberately to the riparian environment, have become aggressively dominant in some river corridors (NRA, 1994). Prior assessment of such introductions can predict and mitigate such impacts and should be considered a necessary function of effective environmental management.

The most common introduction to freshwaters in the UK is that of fish, usually either to replenish stocks of existing species for angling, or for weed control. This guidance note uses grass carp as an example of deliberate introduction of fish species for habitat modification. The impacts of this exotic fish are well documented and illustrate many of the potential problems that may occur when non-native species are introduced to the water environment.

Grass carp (*Ctenopharyngoden idella*) is an herbivorous cyprinid fish that is tolerant of a wide range of environmental conditions. Its natural habitat is in the large rivers flowing into the Western Pacific from the River Amur in Siberia, to Southern China (IFM, 1984). It feeds preferentially on softer vegetation such as duckweeds and canadian pondweed, although more fibrous plants are also eaten. This fish has been used for weed control by the water industry, angling clubs, local authorities and owners of private water; it is judged unable to reproduce in European waters (NRA, 1992).

## 2. Development control

No development control Regulations made under the Town and Country Planning system are applicable to the deliberate introduction of species to the water environment.

Control over the introduction of exotic animals to freshwaters is exerted by the Ministry of Agriculture Fisheries and Food (MAFF) which may issue a licence under the Wildlife and Countryside Act 1981. This Act makes it an offence to release into the wild any animal, including fish and shellfish, of a kind which is not normally resident in, or a regular visitor to, Great Britain in the wild without such a licence. There should be no possibility of introduced fish escaping into river systems and any waters stocked should be enclosed with inlets and outlets adequately fenced.

The 1981 Wildlife and Countryside Act also make it an offence to plant or cause Japanese Knotweed or Giant Hogweed to grow in the wild.

## 3. Environmental Assessment

The deliberate introduction of species to freshwaters is not identified in Regulations made under the European Commission Directive on the assessment of the effects of certain public and private projects on the environment (CEC, 1985) as requiring Environmental Assessment (EA).

Although a formal EA of species introduction is not required, it may nevertheless prove worthwhile to undertake some form of assessment. As the competent authority that determines consent for the release of fish and erection of structures in freshwaters the NRA may request environmental information concerning such proposals. This information may be necessary to enable the NRA to meet its statutory obligations with respect to the protection of the water environment. An EA provides an appropriate method by which an applicant can collate relevant environmental information. It is recommended that the conduct of an EA and subsequent preparation of a report should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents

NRA consent must be obtained under Section 30 of the Salmon and Freshwater Fisheries Act 1975 for the release of fish, or their movement from one site to another. The Authority must be satisfied as to the suitability of a site, particularly with regard to its secure enclosure, and the NRA may specify fencing requirements. Notice must be given prior to stocking of fish and the NRA will then inspect a site to ensure its conditions have been satisfied.

Land Drainage consent will be required from the NRA under either Section 23 of the Land Drainage Act 1991 or Section 109 of the Water Resources Act 1991 for the erection of fences or grids within an 'ordinary' watercourse or main river respectively, as they will constitute an obstruction to flow.

## 5. Major potential impacts

### 5.1 Water quality

The introduction of herbivorous species, such as grass carp, to the water environment may have a beneficial impact on surface water quality. These fish eat floating mats of duckweed, water fern and filamentous algae, and may thereby increase oxygenation of waters through the water/air interface. This can be particularly significant in warm, confined waterbodies, where de-oxygenation of water may have occurred prior to grass carp introduction, due to extensive vegetation growth.

Where high densities of an aquatic herbivore remove a substantial portion of aquatic vegetation, its decay may elevate nutrient levels in water to some extent, although this is likely to be overshadowed by the influence of local geology, soils and land use.

Introduction of any exotic species carries with it a risk that disease and/or parasites may also be allowed to enter local freshwaters. Introductions of grass carp are known to have spread parasites to new countries and continents (Bauer & Hoffman, 1976).

### 5.2 Aquatic ecology

**Fish populations**
If any introduced species are a competitor for habitat, food or spawning areas, or a predator, as is zander, an adverse impact on existing fish populations could be expected to occur. Predation by exotic fish on eggs and fry of indigenous species could also cause an adverse impact on existing fish populations. This has occurred in Scotland, where predation of the eggs of resident salmonid populations by ruffe has comprised a significant impact.

Where an introduced species is not generally a competitor for the resources of native fish, the impact on existing populations may be beneficial. For example, when grass carp are stocked at low to moderate densities, increased growth, production and survival of some other fishes may occur (NRA, 1992). This is partly due to some species feeding on grass carp faecal pellets and partly to habitat change, such as opening up patches of clear water over a period of time, which may favour other fish species that feed on zooplankton.

The introduction of any new fish parasites or disease to a water body by the release of infected fish is likely to have a detrimental impact on existing fish populations. This impact may be severe as native species are unlikely to have any natural behavioural or physiological defence against exotic parasites or disease.

**Aquatic vegetation**
An introduced species can change the characteristics of aquatic habitats by consuming much or all of the existing aquatic vegetation. Such impacts have been recorded where grass carp were stocked in high densities (Bain, 1993). This can be considered a beneficial impact in situations where excessive growth of aquatic vegetation currently reduces water quality, inhibits water flow, or constrains recreational opportunities such as angling. However, in some circumstances this may comprise a major detrimental impact to a native aquatic community, as the existing food chain may be destroyed, or

at least seriously disturbed.

As grass carp are selective in their food, feeding first on soft vegetation, where this fish is introduced to control a relatively unpalatable plant species, desirable vegetation may be reduced drastically before the target species is controlled. Again, this is likely to exert a significant adverse impact on the existing aquatic community.

**Aquatic invertebrates**
When stocked at high densities fish such as grass carp can remove all vegetation even in large water bodies. This may cause an adverse impact on the population density of other herbivorous fish species and also on invertebrates that use aquatic vegetation as a food source, shelter or breeding ground (Taylor et al, 1984). In general, vegetation grazing by grass carp reduces the density and species diversity of plant-dwelling invertebrates but tends to increase the density and diversity of benthic invertebrates due to increased food supply (plant detritus) and dissolved oxygen (NRA, 1992; Bain, 1993).

**Aquatic vertebrates/birds**
Where a fish species is introduced for weed control, the loss of aquatic vegetation and reduction in numbers of some invertebrates is likely to remove or reduce the food supply for amphibians and waterfowl.

Some of the above impacts, such as reduction in aquatic vegetation, may be desirable in the waters that exotic species are introduced to. However, should any non-native species escape into an adjacent water body, they may exert a detrimental impact on the existing aquatic community. If any introduced species is able to breed in UK waters, as are zander, the ecological impacts may become widespread and permanent.

## 5.3 Human-related

The introduction of exotic fish species can change both angling quality and quantity to the detriment of the sport. The introduction of zander to the Great Ouse system, for example, caused adverse impacts, whereby native species suffered predation with a resulting decrease in fish species diversity and numbers, with a consequent loss of angling quality. The introduction of any exotic species for sporting purposes may exert some adverse effect on angling quality, as this can result in an increased angling pressure on a water body. In effect the exotic fish serve to attract new anglers looking for an unusual catch.

In some circumstances introduction of species may improve angling quality. If an exotic species consumes nuisance weeds, as do grass carp, then native fish species may benefit from an improved water quality. The ability of such fish to clear vegetation mats from freshwaters is also beneficial to angling, as the cleared patches attract fish searching for invertebrates and zooplankton. Grass carp themselves are not totally herbivorous and can be taken by anglers on a range of baits. As such they can contribute significantly to angling catches and can provide good sport.

### 5.4 Mitigation measures

Although this guidance note concentrates on fish, specifically grass carp, as an example of the introduction of species for weed control, measures to mitigate any possible impacts on the water environment are broadly similar for any animal species. They must aim to ensure that an exotic species cannot breed or escape into waters other than where they are introduced. Stocking density is critical, both for the effectiveness of a fish as a weed control agent and also in respect of impacts on the water environment. Specific mitigation measures are:

- Where species of flora or fauna are introduced to the water environment for any reason, it is preferable that indigenous local species are used as opposed to exotic species.
- The introduction of exotic species must only be made in accordance with the procedures laid down in the 1981 Wildlife and Countryside Act. Each introduction of a species requires a separate licence issued by MAFF under this Act.
- Exotic species should only be introduced to control aquatic weeds where conditions are appropriate, i.e. that a serious weed problem exists and the exotic species is known to consume specific plants whose growth contributes to the situation.
- Introduction of exotic species should not be made at sites that are within a Site of Special Scientific Interest or National Nature Reserve without the agreement of English Nature or the Countryside Council for Wales.
- It is preferable that introduced species should not be able to breed in UK waters, although it is recognised that some non-native fish species, such as rainbow trout, do breed. The NRA should be consulted as to the suitability of any particular fish species for introduction to UK waters.
- The NRA should be consulted before any formal application to introduce an exotic species, to assess if any habitat modification work will be required on the site to be stocked.
- A proponent should endeavour to ensure only disease-free species are introduced to any water body.
- The local Fisheries Officer of the NRA should be consulted for advice on stocking density of introduced fish. Where a species is introduced for weed control this should not be so great as to remove all aquatic vegetation from a site. In addition introduced species should not offer excessive competition with native species for food resources, shelter or spawning grounds.
- The waterbody to receive an exotic species should be secure, in order to prevent fish escaping into adjacent water systems. Consequently, any water to be stocked should be enclosed and inlets and outlets adequately fenced. Where it is necessary to erect fish barriers, they should be designed to take account of peak flow and water level conditions. An appropriate design for grass carp fencing that is suitable for most fish is provided in *Grass Carp for Aquatic Weed Control: A Users Manual* (NRA, 1992).
- The mesh size of any fencing or outflow screens should be consistent with exotic species size, to minimise obstruction of water flow.

### 7. Baseline surveys

Information necessary to identify and mitigate potential impacts of the introduction of species will include:

- hydrological survey to determine peak flows and water level;
- water quality survey to identify the water temperature cycle and current quality status of any water body;
- comprehensive data on the biology/ecology of any species to be introduced;
- ecological survey to identify existing aquatic flora and fauna.

## 8. Monitoring

A monitoring program should be designed and implemented to assess periodically the number of individuals of an exotic species and the security of the water body concerned. If introduced for weed control, the effectiveness of an exotic population for this purpose should be assessed annually.

## 9. References and guidance

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## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF GROUNDWATER ABSTRACTION

See Guidance Notes 8 and 48.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF INTERBASIN TRANSFER OF FLOW

## 1. Introduction

This guidance note seeks to identify the potential environmental impacts of the interbasin transfer of water. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such developments. The NRA has an interest in proposals for interbasin transfer of flow as it is the licensing authority for water abstraction and has a statutory duty under the Water Resources Act 1991 to secure the proper use of water resources. This statutory duty includes assessing the need for new developments and ensuring that the most appropriate schemes are licensed, taking into account the environmental impact of new developments and the impact on existing users (NRA, 1994a).

Water is currently transferred over large distances for public water supply in many parts of England and Wales (NRA, 1994b). Most schemes are owned and operated by water undertakers but some are owned and operated by the NRA. Several are owned by a water undertaker but operated for the NRA under a Water Resources Act 'Section 20' agreement. It is important to distinguish between transfers that are made via the supply system, e.g. Derwent to Sheffield; Elan Valley to Birmingham to Trent; and river to river transfers, which are the subject of this guidance note.

Water resources in parts of England are presently intensively developed and yet demand continues to rise (NRA, 1994a). The recent drought years have overstretched some existing water resources and excessive abstraction has exacerbated this problem in several areas. There is a significant variation between regions, with the North West, South West and Wales having potentially greater water resources than the South East. Although there is currently an overall surplus in public water supply resources, over the next 30 years further schemes may be needed in most areas (NRA, 1994a). The need for such projects may be enhanced by an adjustment in rainfall as a result of climate change (NRA, 1994c). In order to meet any future shortfalls it may become necessary to increase the movement of water from areas of surplus to areas of need. This may involve 'local' short-distance transfer between river basins of a region, or 'strategic' transfer of water between regions.

The central activities involved in any interbasin transfer of flow involve:
- The abstraction of water from a source supply, which may be a river, reservoir or (exceptionally) an underground source.
- The physical transfer of a relatively large volume of water to an area outside the original catchment basin; this may be achieved by the use of a pipeline, canal or river, or combination of these, as a means of transportation.
- The introduction of transported water into a receiving environment, either a reservoir or a river, within another catchment

This briefing note examines the potential environmental impacts devolving from any scheme for interbasin transfer of flow as an integral development. It concentrates upon the effects of abstraction, movement of water across catchment boundaries and the use of rivers or canals as a transport medium. Impacts resulting from the use of pipelines for water transfer are not described here as they are examined in Guidance Note No. 6 of this series (Pipelines). The impacts of an interbasin transfer scheme must be considered as a whole because Environmental Assessment (EA) of individual components, such as water abstraction or storage, will not reflect the regional issues and impacts involved.

Prior to the design of any specific scheme for interbasin transfer of flow it is essential that all available alternative options are examined in respect of environmental impact. Some form of strategic environmental assessment is necessary at this level of decision making and an example of such analysis is provided by *National Water Resources Strategy: Comparative environmental appraisal of strategic options* (NRA, 1994d).

## 2. Development control

Interbasin transfer of water does not itself fall under the Town and Country planning system. Nevertheless, developments that may be associated with such transfer - such as pipelines, storage reservoirs or pumping stations will be subject to development control and will require consent from one or more local planning authorities.

## 3. Environmental Assessment

The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1199) do not refer to interbasin transfer of flow as a type of development requiring either mandatory or discretionary EA. Activities possibly associated with interbasin transfer that may require EA if they are likely to have a significant effect on the environment by virtue of their nature, size or location (Schedule 2 developments) include drilling for water supplies, long-distance aqueducts and dams or other installations designed to hold or store water. The decision as to whether a proposed development requires EA is for the local planning authority and the responsibility of preparing an environmental statement lies with the developer.

The current standing of interbasin transfer of flow in respect of EA legislation may change in the near future. An unpublished current working document produced by the General Secretariat of the EU Council of Ministers proposes that "works for the transfer of water resources between river basins" over an as yet undetermined annual volume be inserted into Annex I of the original EA Directive (CEC, 1985). If such a proposal were agreed and implemented in UK law, interbasin transfer of water would require mandatory EA in every case (subject to volumetric criteria).

Whether or not all or part of an interbasin transfer scheme is subject to a statutory requirement for EA, it is NRA policy to request environmental information to support applications for abstraction and impounding licences (NRA, 1993). Such information is necessary to enable the NRA to meet its statutory obligations relating to the management of water resources and its duty under the 1991 Water Resources Act to further the conservation and enhancement of natural beauty in respect of proposals relating to its functions. An EA may provide the most appropriate method by which a developer may collate relevant information.

It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement, whether required by Regulations or not, follow the guidelines prepared by the Department of the Environment (DoE, 1995).

## 4. NRA consents/licences

The NRA is the licensing authority, for water abstraction under the 1991 Water Resources Act. This includes abstraction from natural underground storage and from all surface waters above the tidal low water mark. The NRA is also the licensing authority for the impoundment of water. A proposal for interbasin transfer of flow will require one or both of these licenses.

In discharging its obligations as a licensing authority the NRA will apply the principle of sustainability of water resources and where the impact of abstraction is uncertain take a precautionary approach (NRA, 1993).

One or more discharge consents for interbasin transfer of flow will be required from the NRA under the Water Resources Act. Although any discharges during interbasin transfer or to the final recipient water body would be from one controlled water to another, this will not be a natural discharge and therefore must be consented. In addition, without a consent the discharger would be liable if the transfer caused a failure of the Fisheries Directive (78/659/EEC) or Statutory Water Quality Objectives.

## 5. Major potential impacts

Interbasin transfer of flow will benefit those issues any scheme is design to address. These may include security of public water supply, provision for irrigation needs, or enhancement of surface water flow in the recipient area. This guidance note does not examine such beneficial impacts as they will be inherent in the rationale of any transfer project.

The impacts of interbasin transfer of flow upon the water environment can be placed into three broad categories: those devolving from water abstraction, those associated with physical transfer of water and those resulting from discharge of water to a recipient body. This guidance note deals with each separately but in an EA of interbasin transfer the potential impacts of a scheme should be considered as a whole, i.e. the total of potential environmental benefits and costs should be examined.

This Guidance Note does not consider any impacts devolving from general construction activities associated with an interbasin transfer scheme. Guidance Note 1 of this series (General construction) is relevant to such issues.

## 5.1 Water abstraction

Water may be abstracted from an underground source, river, lake or reservoir for interbasin transfer. A single scheme could involve several abstraction points during transfer. For example, water may be drawn first from an aquifer then transferred by river or canal; later, water might be abstracted from the transfer river or canal to be moved on by pipeline. Therefore impacts of abstraction activities are likely to be felt at more that one point in the transfer chain.

Where a primary abstraction point for transfer is to be a pumped storage reservoir, the actual source of water will be those natural water bodies whose supplies would be depleted and an EA should examine impacts on those components.
Potential environmental impacts associated with points of large abstraction are described in detail in Guidance Note 8 of this series. In summary these are:

**Groundwater abstraction**
- Change in groundwater level,
- Reduction of river flow and/or river level (this may have substantial secondary and tertiary impacts on river morphology and ecology).
- Loss of wetland and riparian habitat caused by lowered water table.
- Diminished abstraction potential for existing water users.
- Change in the quality of groundwater, including saline intrusion in coastal areas.

**Surface water abstraction**
- Change in geomorphological profile of source river.
- Fall in river water quality due to decreased effluent dilution capacity, reduced aeration and higher summer water temperatures.
- Increased algal growth with associated change in biochemical oxygen demand (BOD) and pH.
- Increased upstream penetration of saline tidal waters.
- Change in aquatic and marginal riverine habitats.
- Loss of species sensitive to low water flows.
- Loss of fish habitat and decreased value as a fisheries resource due to change in fish behaviour, interruption of migration and loss of spawning grounds.
- Navigation may be limited by a reduction in water depth.
- Reduction in the recreational and public amenity value of surface waters as a result of decreased flow and change in water quality.

## 5.2 Water transfer

The physical transfer of water between river basins may utilise pipelines, tunnels, rivers or canals as transportation media. A capacity for water storage may be required at the receiving end to allow for the eventuality of a dry summer when little or no water abstraction and transfer is possible. Other guidance for EA relevant to this aspect of interbasin water transfer include Guidance Note 2 (Reservoirs) and Guidance Note 6 (Pipelines) of this series. This guidance note examines potential impacts upon canals and rivers only.

**Hydrology/morphology**
The interbasin transfer of water utilising an existing watercourse may substantially affect the flow regime and hydrology of a channel used for this purpose. An increased water level within a canal or river may cause the water table to rise, which may in turn impact upon adjacent land used for agriculture and also wetlands. Increased water depth and flow may increase the risk and frequency of flooding in downstream areas.

The bed and banks of an existing watercourse may undergo significant change, including sediment redistribution and increased bank erosion, as a result of enlarged flow volume and/or higher velocity. Increased water velocities may also change the particle size distribution of a river bed. There may be substantial erosion immediately adjacent to a transfer introduction point with eventual deposition of material downstream. If interbasin throughput is sporadic then the geomorphology of a watercourse used for transfer is likely to become and remain unstable.

Transfers along rivers or canals are likely to exert an impact on the operation of man-managed structures such as sluices, locks and mills.

**Water quality**
Water quality within any transfer channel may be changed as the chemistry of a donor water body is unlikely to be identical to that of a transfer river or canal. Where water chemistry is very different as, for example, in water from an acidic source moving through a limestone area, the impact may be profound. In addition, tansfer of water between, for example, a canal and a river is likely to reduce water quality within that river if lower quality canal water, in terms of dissolved oxygen, BOD, suspended solids and high levels of nutrients, is pumped to the river system. Any such reduction of water quality in a transfer channel may exceed limits imposed by the EC Freshwater Fish Directive (78/658/EEC) on the quality of fresh waters needing protection or improvement in order to support fish life and also Statutory Water Quality Objectives.

It is possible that trace contaminants, such as metals or pesticides, could result in adverse impacts on the quality of recipient waters, even after being diluted and transferred over a considerable distance.

Pathogens not native to an area may be introduced by the bulk input of water from another region. These may include fish and plant disease agents and parasites.

Where groundwater is used as a source for interbasin transfer, deposition of ochre and/or change in temperature, dissolved oxygen and pH could occur within a transfer channel.

**Ecology**
Ecological impacts related to hydrological change may include the loss of shallow water habitats and change to the existing riparian flora and fauna along the transfer route. If interbasin transfer is regulated to such an extent that water flow within any transfer channel is more or less constant, this will create a highly un-natural flow regime, with probable adverse impacts on marginal habitats and fish populations. Alternatively, where changing demand requirements or supply availability cause flow transfers to be sporadic or erratic, it is possible that some habitats and species will be unable to exist within these highly variable conditions and may therefore disappear completely.

A change in water velocity within any transfer channel is likely to alter the invertebrate composition of the benthos. For example, an increased water velocity would favour those invertebrates best adapted to rapid flow at the expense of species or taxa suited to slower velocities. Such conditions are also likely to increase invertebrate drift, with consequent redistribution of benthic species.

If a water transfer is suddenly halted, fish which have been encouraged to swim into the upper reaches of a transfer or recipient watercourse by unnaturally high flows may become stranded. Migratory fish may alter their behaviour as a result of changes in water flow or water chemistry within a transfer channel. Although the overall impact of interbasin transfer on fisheries is likely to be neutral or even beneficial, where river flow is augmented during drought, increased water velocities may affect fishing catches.

Change in water quality may significantly alter the species composition and distribution of flora and fauna within a transfer channel. If any of the natural parameters of pH, BOD, dissolved oxygen, nutrient status, suspended solids or temperature within a watercourse are altered by interbasin transfer of flow, the aquatic and marginal communities may be expected to change also.

New species of flora or fauna may be introduced to a watercourse by interbasin transfer of flow. Any new species may alter existing ecological dynamics and community composition. Zander, a non-indigenous fish which predates a native fish in central and eastern Europe have probably been carried in the past from one catchment to another by water transfers. Transfer of water from the lower reaches of one river to the upper reaches of another may seed this with algae or spores. These, combined with a possible increase in nutrient levels that could occur in some situations, may result in accelerated phytoplankton growth and algal blooms.

**Navigation/recreation**
Fluctuations in water level and velocity resulting from sporadic interbasin transfer may impede navigation and some recreational activities along a watercourse used for transfer. Some water users, such as canoeists and anglers, may welcome such fluctuations as they could benefit these sports by providing a diversity of conditions. The nature and intensity of such impacts will depend on the natural flow characteristics of any watercourse and the degree of flow variation caused by interbasin transfer.

## 5.3 Water discharge

The final discharge point for interbasin transfer of flow is most likely to be a storage reservoir. Water may then be pumped to the public supply system. This will eventually impact on surface waters downstream as an additional water volume is added to a watercourse or catchment area via the public sewerage system. Alternatively, water may be abstracted directly from a interbasin transfer channel for subsequent treatment and public supply. The potential impacts of this aspect of interbasin transfer on the water environment are described here in broad terms only, as their nature will depend on the characteristics of the receiving water body and the transfer route taken.

### 5.3.1 To surface waters

Where the final interbasin transfer is discharged directly to a river the potential impacts are similar to those previously described for river/canal transfer channels. These include:
• Possible transfer of species and disease between catchments.
• Increased bed and bank erosion, particularly near the point of discharge.
• Change in river profile and sediment distribution.
• Flood risk.
• Loss of shallow water habitats.
• Effect on flora and fauna of mixing water of different chemistries.
• Effects of changed river flow/chemistry on fish migration and breeding.
Some of these impacts are likely to be intensified if transfer discharge is sporadic.

Where interbasin transfer is discharged to a reservoir the chemical characteristics of the mixed waters are likely to fluctuate, with possible adverse impact on the existing flora and fauna. Any introduction of new species or pathogens could have a profound impact on the population dynamics of such a water body. For example, it is conceivable that introduction of exotic phytoplankton would result in algal blooms if new species were particularly well suited to the prevailing conditions. Similarly, the introduction of new invertebrate or fish species could alter an existing herbivore/predator food chain. The introduction of disease agents or parasites could exert a dramatic adverse impact on existing plant, invertebrate or fish populations.

If interbasin transfer is discharged first to a storage reservoir and later as a controlled release to a river, habitat diversity within that watercourse may decline as a result of flow regulation. This could cause a reduction in species diversity, including that of fish. Other impacts of such discharge are likely to be similar to those described above for final discharge to a river, except that retention time in a storage reservoir will have allowed for mixing of waters and this may reduce the intensity of change in the chemical composition of the recipient river. Nevertheless, where "bottom water" is discharged from a storage reservoir stratified by water temperature, the discharge may alter temperature and pH within the recipient watercourse.

Interbasin transfer with controlled release of discharge could have beneficial impacts on a receiving watercourse in some circumstances. These include:
• Protection against very low flows in dry periods.
• Increased dilution of effluents - leading to an improvement in river quality.
• Enhanced navigation and recreational opportunities.

## 6. Mitigation measures

### 6.1 Abstraction

In order to reduce or avoid impacts associated with abstraction of water for interbasin transfer from a surface or groundwater source, an appropriate timing and volume of water extraction must be defined. Abstraction licences are the primary mechanism for mitigating such impacts, although operational agreements may also be used. Any licence or agreement will need to ensure a minimum level of water remains at all times within a donor water body. This may necessitate the provision of some storage capacity at either end of the transfer chain, to be filled in winter months. Storage capacity at the donor site would ensure interbasin transfer is not abruptly halted, with possible consequent adverse impacts to transfer channels. Storage capacity at the terminus of a transfer chain would protect the recipient water body from rapid reduction in water flow volume, when some agreed abstraction limit is reached in drier periods.

### 6.2 Transfer

Transfer of water over long distances by river or canal is likely to lead to some loss by evaporation and leakage. The water volume introduced to a transfer channel may therefore be larger than that discharged to a recipient body. In order to mitigate some of the many potential impacts associated with transfer, sporadic transfer flows should be avoided. The provision of a water storage capacity at each end of any transfer channel will assist the maintenance of a regular throughput. Conditions for individual abstraction licences and discharge consents along an interbasin transfer chain can be used to minimise impacts, although an integrated suite of licences and consents will be required if regulation is to function effectively.

It would be difficult, if not impossible to attempt to mitigate specific localised impacts, such as bank erosion or loss of marginal habitat, along the entire length of a transfer channel. Nevertheless, sections of watercourse particularly susceptible to these, or any other impacts, should be protected where possible. This would be especially desirable where surface waters possess a high value in terms of conservation or recreation. Other guidance notes relevant to possible mitigation measures applicable to specific impacts on transfer channels are Guidance Note No. 31 (Channel Works), No. 32 (Bank Protection) and No. 34 (Flood Embankments).

### 6.3 Discharge

Discharge of interbasin transfers should ideally be made first to a storage reservoir in order to minimise impacts on the water environment. This would dissipate energy of transfer flow, provide storage capacity to be used when little or no transfer is possible and also enable regulation of discharge to a recipient watercourse. Retention in a storage reservoir will also allow mixing of waters and so reduce potential adverse impacts on the water chemistry of receiving waters. However, the size of the volume transferred may militate against the provision of storage on a truly effective scale, as very large costs would be incurred by construction of sufficient volume of storage. Discharge of interbasin transfers to storage reservoirs should therefore be considered desirable, but perhaps not essential, as this may not always be justifiable in terms of costs and environmental benefits.

Where the final discharge of an interbasin transfer is made directly to a river, discharge consents provide a mechanism for reducing impacts on the recipient watercourse.

## 7. Baseline surveys

A developer bears responsibility for the production of an environmental statement or report, yet the nature of EA of any proposal for interbasin transfer of flow will demand close co-operation between developer and NRA. This is likely to be particularly relevant regarding the identification and acquisition of appropriate baseline information and early consultation is recommended.

Some components of baseline survey applicable to interbasin transfer of flow are identified in *Water: Nature's Precious Resource* (NRA, 1994a) but a comprehensive identification of baseline requirements has been made by the Water Resources Zap Team (NRA, 1995). The major elements of appropriate baseline information are outlined below under headings of abstraction and discharge. A single scheme may involve several points of both abstraction and discharge during regional transfer and these data would be applicable for each occurrence.

### Abstraction

Abstraction from groundwater would require detailed hydrogeological and hydrological data as baseline information. Data concerning the downstream flow regimes of surface waters would also be necessary with information requirements being similar to those needed in the case of direct abstraction from a river.

Abstraction from surface waters would require baseline data and surveys concerning:
- river or canal flow, velocity and depth (time series);
- water quality (time series) - it is important to ensure comparable parameters are used in donor and recipient water bodies;
- channel morphology;
- aquatic, marginal and riparian ecology;
- fisheries and recreation flow needs and valuation.

### Discharge

Discharges resulting from interbasin transfer of flow to river or canal would also require baseline information concerning:
- river or canal flow and depth (time series) - this could be supplemented by velocity and wetted perimeter, for a number of typical flows, at key sites to allow PHABSIM type analysis;
- water quality (time series) - it is important to ensure comparable parameters are used in donor and recipient water bodies;
- channel morphology;
- aquatic, marginal and riparian ecology;
- fisheries and recreation value.

In addition, data from both donor and recipient waters would be required concerning:
- water chemistry (using a more comprehensive suite of determinands than is normally analysed for quality assessment);
- algal characteristics;

- macrophyte characteristics;
- macroinvertebrate composition;
- fisheries characteristics;
- disease and parasite characteristics.

Final discharge to an underground water body would require detailed hydrogeological and hydrological data as baseline information.

## 8. Monitoring

A comprehensive monitoring program should be planned and implemented as an integral part of project design. This should include monitoring of the hydrology, ecology and water quality of donor, transfer and recipient water bodies. Monitoring should be directed at protecting set minimum levels of flow in donor and transfer water bodies and a maximum level in the recipient so that transfer volume can be adjusted accordingly. Geomorphological monitoring of transfer channels below discharge points may also be appropriate.

## 9. References and guidance

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide.* HMSO, London.

National Rivers Authority (1993) *NRA Water Resources Strategy.* NRA, Bristol.

National Rivers Authority (1994a) *Water: Nature's Precious Resource - An Environmentally Sustainable Water Resources Development Strategy for England and Wales.* HMSO, London.

National Rivers Authority (1994b) *Major Surface Water Schemes in England and Wales.* NRA, Bristol.

National Rivers Authority (1994c) *The Implications of Climate Change for the National Rivers Authority.* NRA R & D Report 12, HMSO, London.

National Rivers Authority (1994d) *National Water Resources Strategy: Comparative Environmental Appraisal of Strategic Options.* NRA, Bristol.

National Rivers Authority (1995, unpublished) *Water Resources Developments: A Framework for Scoping Environmental Baseline Data Requirements.* Water Resources Zap Team, NRA, Bristol.

Commission of the European Communities (1985) On the assessment of the effects of certain public and private projects on the environment. *Official Journal,* L175, 28th May, Brussels.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF AGRICULTURE

## 1. Introduction

This guidance note seeks to identify the potential impacts of agriculture upon the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of agricultural developments or activities. The NRA has an interest in agricultural operations due to its statutory responsibilities with respect to the protection of water resources, water quality, fisheries and the general aquatic environment.

The agricultural sector conducts a wide range of operations that may impact upon surface or ground waters. In broad terms these fall into categories of:
- use of water resources for irrigation and livestock;
- change of land use or land drainage;
- activities causing inputs to surface and groundwaters.

Some agricultural developments and activities are subject to statutory control, regulation or guidance in order to minimise their environmental impact. Hoever, many are not and the NRA seeks to avoid or reduce their impact upon the water environment by a variety of means. These include the exercise of its responsibilities as the regulator of abstraction from and discharge to the water environment, in the role as statutory consultee to certain developments and by liaison with the agricultural industry and other government bodies.

This guidance note deals with general agricultural practices. It identifies major potential impacts on the water environment associated with such activities and indicates mitigation measures that can be used to avoid or reduce those impacts. It should prove useful to farmers who need to assess the impact of their operations, or who wish to minimise the risk of damage to the water environment. It will also be relevant to NRA staff engaged in monitoring and protection duties.

Environmental assessment (EA) of intensive livestock and poultry units is not dealt with here but is described in Guidance Note 51 of this series. EA of fish farms is described in Guidance Note 5. Developments associated with these forms of husbandry may require a formal EA to accompany any application for planning permission.

## 2. Development control

Many agricultural activities are exempt from local authority development control under the Town and Country Planning system. Permitted development rights are given for a wide range of agricultural operations such as buildings, drainage works and excavations. There are some limitations to these rights, however. For example, the erection or alteration of structures for the accommodation of livestock is excluded from the 1995 Town and Country Planning (General Permitted Development) Order (SI 1995 Nº 418) if the ground area is to exceed 465m$^2$, or the proposed development lies within 400m of non-agricultural dwellings or other buildings. Farms that are less than 5 ha in area have more stringent restrictions on permitted development than do larger units.

It is not the purpose of this guidance to list those agricultural developments or activities that would or would not require planning consent from a local authority. Responsibility for ensuring any new development it complies with the requirements of the Town & Country Planning system, lies with the developer, and a guide to relevant aspects of the planning system is available (DoE, 1992).

## 3. Environmental Assessment

No agricultural developments are listed as Schedule 1 projects that require mandatory EA under the 1988 Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 № 1199). Several classes of developments associated with agriculture are designated as Schedule 2 projects. As such they require a formal EA if they are likely to have a significant effect upon the environment by virtue of their size or location. These developments (excluding fish-farming) are:

- water-management for agriculture;
- poultry-rearing;
- pig-rearing;
- the reclamation of land from the sea.

Even where a formal EA of an agricultural development is not required by a local planning authority, it may nevertheless prove worthwhile for the developer to undertake some form of assessment. The NRA is the competent authority that determines consent for discharges to the water environment and licences water abstraction (see next section). As such it may request environmental information concerning any proposed discharge or abstraction. Such information may be necessary to enable the NRA to meet its statutory obligations with respect to the protection of the water environment, particularly in regard to the control of pollution of surface and groundwaters. An EA may provide the most appropriate means for collating relevant environmental information. This could follow the guidelines prepared by the Department of the Environment (DoE, 1995) in relation to development projects.

## 4. NRA consents/licences

Statutory controls over discharges affecting the water environment are contained in the Water Resources Act 1991 (WRA). Under Section 85 (1)(a) of this Act it is an offence to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste to enter controlled waters. No offence is committed where the NRA has given consent under Section 88 of the WRA. The NRA may place conditions upon a discharge consent regarding the place of discharge, its nature, treatment prior to discharge, provision of monitoring devices and recording of discharges made. Discharge consents are reviewed periodically and the NRA may then vary or revoke a consent.

The NRA is the regulatory body authorised to licence the abstraction or impoundment of water from surface or underground sources under Part II of the WRA. All abstractions for spray irrigation require a licence under this Act. An application can only be made by the occupier of land adjacent to overground water or above underground strata when considering an application. The NRA must have regard to the rights and privileges of those who would be affected by the grant of a licence. In addition, the Authority is under a duty to have regard to the level of flows in inland waters, and to the environmental and recreational duties imposed on the NRA by the 1991 Act.

The NRA is responsible for enforcement of the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations 1991. These Regulations set legal minimum standards for silage, slurry and agricultural fuel oil installations in England and Wales. New, substantially enlarged or substantially reconstructed installations must meet specified criteria and the NRA should be notified at least 14 days before an installation is brought into use. Existing installations are not affected by the Regulations unless the NRA considers they pose a significant risk of pollution. In this case a notice requiring improvement works may be served and the installation may loose its exemption under the Regulations. The 1991 Regulations will be amended in 1996.

## 5. Major potential impacts

Potential impacts upon the water environment due to agricultural operations are many and diverse. There is also a significant regional variation across England and Wales in the form of agriculture undertaken and consequently the type of impacts that may be expected. This guidance note concentrates upon those activities deemed most likely from past and current experience to result in significant impact to surface or underground waters. Nevertheless, the cause and severity of impacts resulting from agricultural operations are likely to vary between the regions and with precise location. NRA personnel will use their local expertise to determine what issues are most relevant within an area. Local knowledge is particularly valuable where cumulative impacts upon surface or ground waters are likely to exist, and prospective developers should undertake early consultation with the NRA so that key issues may be identified.

### 5.1 Use of water resources

Water is used in agriculture primarily for the irrigation of arable crops. This practice generally increases yield, quality, reliability and continuity of production. Watering of livestock and general cleaning operations also use a considerable volume. Agricultural water may be abstracted directly from a watercourse or underground strata. Agricultural demand on water resources is of particular importance since it is predominantly consumptive use (i.e. not returned to watercourses or aquifers after use), is required most in times of drought and tends to be concentrated in areas that do not have a large resource surplus (NRA, 1995a).

One percentage of all water abstracted from surface and groundwaters is used in agriculture. The "most likely" prediction for growth in volumetric agricultural demand is 1.7% per year from 1996 to 2001 and 1% per year from 2001 to 2021 (NRA, 1994a). Over 80% of the projected demand is from the Anglia and Severn-Trent areas, with the highest proportion in summer, when resources are scarce. It is possible, although by no means certain, this rate of growth in agricultural demand for irrigation water will be increased by the effects of climatic change. Change in mean temperature, rainfall or evaporation will have a direct effect upon soil moisture and therefore agricultural demand. Although climate models cannot reliably predict regional climate change, the best estimates suggest that the frequency of warm summers will increase considerably (CCIRG, 1991).

Water use by agriculture will contribute to any depletion of groundwater resources and/or lowering of river flows. Such impacts are particularly important at present as the UK has experienced several years of relatively low rainfall with a consequent reduction in river flows and groundwater recharge.

Depletion of groundwater resources may exert a considerable influence on both private water supplies and the water supply industry. This would impact primarily upon water consumers within those areas of England and Wales most dependent upon groundwater supply. Lowering of a water table may also affect surface water drainage.

Reduction in river flows may affect the physical, chemical and biological characteristics of surface waters. Reduced flow velocities will likely cause increased deposition and may change an existing river bed profile. This, in conjunction with reduced flow volume, may dramatically alter riverine habitats. Changes in the species composition, diversity and biomass of both flora and fauna could be expected. Sensitive species and habitats may be lost. Low flows may prevent or disturb the normal pattern of fish spawning and, if very low river flows occur, fish kills may result.

A reduction in river volume and/or velocity may reduce the dissolved oxygen content of a river as surface area and turbulence, major factors in gaseous exchange, are diminished. Water temperature could increase, which in turn would further reduce dissolved oxygen and also enhance algal and bacterial growth. Low flows would reduce the dilution capabilities of any watercourse and may cause a sharp deterioration in water quality if organic inputs such as farm wastes, field runoff or sewage are present. Reduced river flows may also exert adverse impacts upon recreational opportunities such as boating and the role of rivers as fisheries.

## 5.2 Change of land use or land drainage

A change of land use within agricultural operations may take many forms. The erection of buildings, laying of roads, hedgerow removal and conversion of land from pasture to arable farming are examples. Any such change would affect natural surface water drainage and would impact upon the hydrology of local streams or rivers. This may alter stream flow and increase the potential or frequency of flooding. A change in land use is often accompanied by improved drainage of the area concerned. The impacts caused by improved drainage and land use change may often prove difficult to separate.

### 5.2.1 Change of land use

The hard surfacing of yards or roads, or erection of buildings within an agricultural property may result in a significant alteration of existing surface water runoff. If rainwater is not discharged directly to a public or private drainage system then land surface or river bank erosion may occur and increase stream turbidity could also result. Loose excavated material on a development site during construction operations may also be washed into a watercourse and cause an increase in suspended sediments. An increase in the intensity of flooding is likely in periods of high rainfall due to the rapid runoff of surface water from covered areas.

A change in land use may take the form of new developments for animal husbandry, chemical storage, vehicle parking or maintenance. It is possible that harmful contaminants from these operations, such as oil, animal wastes or agricultural chemicals, could enter surface or groundwaters unless adequate collection and storage facilities are available.

Change of land use from one agricultural practice to another may impact upon surface waters. For example, ploughing of established pasture on sloping ground can cause severe soil erosion with consequent deposition of material in nearby watercourses and alteration of stream geomorphology, hydrology, chemistry and habitat. Hedgerow clearance woud result in loss of habitat and also have a visual impact on thge surreounding landscape. The removal of hedges could also result in localised soil erosion. Change of land use may also modify the infiltration of water and therefore impact on groundwater resources.

### 5.2.2 Agricultural drainage

Many agricultural soils require drainage to assist production and this may cause detrimental impacts to the hydrology and quality of surface waters. Natural land drainage can be enhanced by ditch drainage at field boundaries or subsurface drainage pipes or channels. In most cases a change from natural to improved drainage causes an increase in peak runoff rate (Skagg *et al*, 1994) that will result in increased peak stream flow. Improved drainage generally increases sediment load in surface waters (Hill, 1976) and this may be particularly dramatic if improvement is accompanied by a change in land use, from pasture to arable for example. An increased sediment load may result in greater turbidity of surface waters, sediment deposition and alteration of aquatic habitats. In addition to the possible destruction of existing benthic flora and fauna, extensive sediment deposition may also destroy fish eggs and juveniles in fish spawning areas.

Improved drainage will speed up the movement of both natural and artificial nutrients from agricultural land into any nearby watercourse. This may be a particular cause for concern if land is used for spreading of animal slurry or receives an intensive application of inorganic fertiliser. In either case, high rainfall may wash a high proportion of these nutrients directly into surface waters where they may cause excessive algal growth, eutrophication and depletion of dissolved oxygen. The impacts of nutrients on surface waters are described in a following section. Improved agricultural drainage will serve to intensify these impacts. Similarly, improved drainage will increase the rate at which pesticides move from agricultural land into surface waters. This is likely to intensify the impacts of pesticide contamination which are described in a later section.

## 5.3 Inputs to surface and groundwaters

Modern farming practice has increased the opportunity for a variety of pollutants to enter surface and groundwaters. A rise in stock numbers and intensification of livestock farming has enlarged the volume of animal wastes produced by individual farms. Silage production has increased dramatically in recent years, while intensive arable farming requires a liberal input of organic or inorganic fertilisers and pesticides. Thus the risk that agricultural pollutants may contaminate surface or groundwaters is greater than ever before. Acute contamination of surface waters by organic waste is easily visible, yet diffuse pollution of surface and groundwaters from non-point sources is equally problematic and presents a serious risk of long-term degradation of these resources.

Potential impacts of agriculture upon the water environment are presented here in four broad categories. This Guidance Note does not discriminate between, for example, different types of organic fertiliser or pesticide, but provides a generalised picture of what impacts to water resources may be expected from input of each category.

### 5.3.1 Organic wastes

The majority of all reported farm pollution incidents are due to organic wastes. Of the pollution incidents caused by these wastes in 1994, cattle slurry accounted for 33%, cattle manure (solid) for 9% and silage liquor for 8% (NRA 1995b). Milk and dairy washings together caused 6% of pollution incidents. These contaminants may enter the water environment by leakage or overflow from collection and storage facilities, as contaminants of shed or yard washings or by surface or sub-surface drainage transport after field spreading of fertiliser. Non-agricultural organic wastes, such as sewage sludge, may also contaminate surface or groundwaters when used as a soil fertilising material.

Organic wastes produced from many types of agricultural facilities or practices may impact upon the water environment. In general, the most common are:

- **Silage stores**: silos may leak and allow silage liquor to seep and bypass collection systems. Silos may be of an inadequate size or badly sited, resulting in leakages having direct access to land drains or a watercourse.
- **Slurry lagoons or stores**: these may be of inadequate capacity or construction, or sited adjacent to watercourses, springs or land drains. Overflow of inadequate slurry storage facilities is a common occurrence.
- **Clean water separation**: if rainwater can enter collection or storage facilities for of organic waste the system may become overloaded and flooding could occur.
- **Slurry application**: field application of slurry as fertiliser may be made at an excessive rate, in an inappropriate location or at an unsuitable time of year. The use of external contractors for slurry spreading can result in inappropriate application practices.
- **Dairy facilities**: washing of dairy parlours, poor milk storage or disposal of dairy wastes can result in contamination of surface waters, unless the liquids are directed to the public foul sewer or a treatment facility.

A practical guide to help farmers and growers avoid many of the issues raised in this section of the Guidance Note is available from the Ministry of Agriculture Fisheries and Food (MAFF, 1991).

#### Surface water

The potential impacts for surface water-quality from organic wastes are broadly similar. They differ only in intensity between catastrophic point source contamination, such as storage container failure or overflow, and the long-term diffuse contamination resulting from field application as fertiliser. An important consideration in the assessment of potential impacts is the dilution capability of affected surface waters.

Organic wastes contain fats, carbohydrates, proteins, nitrates, phosphates and ammonia. Upon entering surface waters these substances are oxidised by microbes into simpler compounds. A common characteristic of all organic wastes is their high biochemical oxygen demand (BOD) and the primary impact of such wastes upon surface waters is therefore depletion of dissolved oxygen. Silage liquor is a particularly significant contaminant in this respect as it has a BOD of 30,000-80,000mg/litre (MAFF, 1991) which is three times the demand of cattle slurry. If waste input is sudden, extensive invertebrate and fish kill may be expected. An intermittent or continuous discharge may result in the disappearance of sensitive species and a slow but significant change in the aquatic community. An extensive growth of 'sewage fungus' (a mix of algae and bacteria) is a characteristic feature of chronic silage or slurry pollution.

Waste such as cattle slurry contains a high concentration of ammonia, which is toxic to many forms of aquatic life, particularly fish, and may contribute toward eutrophication of waters. Excess total ammonia is the most common cause of non-compliance with the EC Freshwater Fish Directive (78/658/EEC) on the quality of fresh waters needing protection or improvement in order to support fish life. Farm drainage problems have been identified as one of the primary causes of failure (NRA, 1994b).

Organic waste often contains a large quantity of inert material and in water this, along with the products of microbial decomposition, are present as suspended solids. These may increase turbidity and upon settling out, physically alter the sediment characteristics of large areas of river bed. Local aquatic habitats may undergo significant change as they become covered with sediments and invertebrate fauna may be displaced. The survival rate of fish eggs and juvenile fish may decrease as spawning gravels are smothered. As microbial decomposition continues within these deposits, a stream bottom can become covered with anoxic (oxygen-free) mud which may produce methane.

Organic waste will usually contain micro-organisms some of which, such as *Cryptosporidium*, may be pathogenic. Contamination of a watercourse by these disease agents may result in a direct threat to human health and may render the water unfit for use as a supply source.

The major direct impacts of organic wastes upon surface water quality may result in a plethora of indirect or secondary impacts. These may include habitat change, species loss, offensive odour, adverse visual impact, disruption of fish breeding or migration, loss of amenity and loss of recreational value.

The significance of impacts caused by organic waste contamination will depend upon the physical, biological and utility characteristics of a watercourse. The width, depth, flow and slope of a stream may or may not act to mitigate some impacts and as previously indicated, the dilution capability of a watercourse is important for this reason. The existing ecological characteristics of a stream, in terms of rare/sensitive flora, fauna or habitat, may be such that even minor contamination by organic waste will cause a significant impact. Similarly, the utility value of a watercourse, whether as a water supply source, recreational resource or fishery, will increase the significance of any level of organic contamination.

**Groundwater**

The high BOD of organic wastes does not significantly affect underground water resources, although farm effluent contamination of springs and small borehole sources may cause adverse impacts to the taste, odour and colour of groundwater. Major potential impacts of groundwater contamination by organic wastes derive primarily from the nitrate content of the material. Accordingly, the impacts of these wastes upon groundwaters are included in the following section which deals with nutrients.

The presence of micro-organisms in organic wastes may give cause for concern if groundwater at risk of pollution is a supply source for either human or agricultural use. Such pollution may be deemed a risk to human health.

### 5.3.2 Nutrients

Nutrients are essential for plant growth. The most common nutrients include nitrogen, phosphorus and potassium. These are naturally present in soils, usually as nitrate, phosphate and potassium compounds. Some low-level input of nutrients to surface and groundwaters is therefore a natural process. Modern agriculture has increased the input of these nutrients to waters by widespread application of inorganic fertilisers, animal wastes and sewage sludge. Nutrients may enter surface waters directly by rainwater transport, sub-soil percolation or soil erosion. Additional inputs of nutrients may derive from the leakage of silage liquor, fertilisers or dairy wastes or from the ploughing of established grassland.

Nitrates are highly soluble and may enter underground strata dissolved in rainwater. The widespread agricultural application of nutrients, the high solubility of nitrates and their toxicity to humans has made the issue of nitrate contamination of surface and groundwaters one of international concern. The EC Directive on Diffuse Pollution by Nitrates (91/676/EEC) requires nation states to monitor the current situation and identify areas vulnerable to nitrate contamination. The Water Resources Act 1991 contains powers to designate water protection zones and Nitrate Sensitive Areas proposed by the NRA where some activities likely to result in water pollution by nitrates are restricted.

**Surface water**
The input of nutrients to surface waters may result in excessive algal growth, or eutrophication. Phosphate is most often the limiting nutrient for algal growth in freshwater and the artificial addition of this nutrient may cause explosive "blooms" of algae. Algal blooms have an adverse visual impact, may be detrimental to other aquatic vegetation and may have serious cost implications where surface water is used for public supply, as the alage can block sand filters used in purification of drinking water.

A high concentration of nitrates in surface waters may render it unfit for use as a public supply source.

Eutrophication of surface waters may cause invertebrate and fish kill by destabilising the normal oxygen balance of waters or through the production of toxins by blue-green algae, which may also be harmful to mammals. Eutrophication may alter the pH of affected waters.

**Groundwater**
Intensive agricultural production, involving widespread use of organic and inorganic fertilisers, may lead to nitrate contamination of groundwater. The risk of such contamination is largely dependent upon local geology and is highest where permeable upper strata allow surface water to percolate to lower depths. Impermeable upper strata

will not allow downward percolation and contaminated sub-surface water may migrate laterally to eventually enter surface waters.

Where groundwater aquifers are used for public water supply the presence of an abnormal concentration of nitrates is considered to pose a direct threat to human health.

**5.3.3 Pesticides**

Pesticides such as insecticides, herbicides and fungicides are commonly used in agriculture. They are not usually specific to a particular pest and therefore may be toxic to a wide range of animals and plants. There are currently about 450 active pesticide ingredients available in the UK (NRA, 1992). Their use is controlled by Part III of the Food and Environment Protection Act 1985, the Control of Pesticide Regulations 1986 and other regulations made under the Health and Safety at Work etc., Act 1974.

Pesticides can enter the aquatic environment from crop spraying, sheep dips and the inappropriate storage, mixing or disposal of the chemicals. Some are directly toxic to aquatic organisms while others may accumulate in organisms and move through a food chain in increasing concentrations.

Pesticides used for crop protection may reach a watercourse through runoff or leaching. Up to 1.1% of applied pesticide has been observed to enter surface waters (Williams *et al*, 1995). Entry to a watercourse may be enhanced by improved agricultural drainage. As is the case for most pollutants, the dilution capability of receiving waters will influence the intensity of impact. Direct impacts for surface waters may include loss of riparian vegetation and disturbance of aquatic invertebrate and fish populations. An acute pollution incident from pesticide spillage or careless disposal could result in localised destruction of all aquatic plants or animals. Secondary impacts may include injury to wildfowl and other vertebrates that feed in the aquatic environment. Contamination of surface waters by agricultural pesticides may present a threat to drinking water supplies.

Some pesticides, particularly herbicides, are attenuated in the soil and upper strata and are believed to present little risk to groundwater quality under normal agricultural usage (NRA, 1995c). Some others are more persistent and present a distinct threat to groundwater quality. This hazard is related to the amount, repetition and timing of pesticide application and the ease with which it may pass through underground strata. The impact of agricultural pesticides upon groundwater will be greatest where an aquifer is used for potable water supply, as a direct threat to human health may be present.

The use and disposal of sheep dip has received special attention in recent years with regard to its potential impact upon surface and groundwaters. Surface water pollution incidents are most common during the sheep dipping season (Littlejohn *et al*, 1991) but sub-surface lateral migration of the pesticide from a dipping area may result in a diffuse, long-term input to a watercourse or groundwaters (NRA, 1994c). The increasing use of mobile sheep dips presents further risks unless adequate precautions are taken in their siting and in the disposal of spent dip. The potential impacts of sheep dip upon the water environment are much the same as for pesticides in general. Yet as the active components of sheep dip are particularly toxic and the risk of acute pollution incidents is higher than that of, for example crop spraying, the impact of sheep dip on surface waters may be more intense than those of other pesticides.

### 5.3.4 Diverse pollutants

This section covers impacts from agricultural inputs to surface waters that do not easily fit into the preceding categories.

**Disinfectants**

Disinfectants are routinely used in agriculture for sanitation purposes, such as cleaning of milking parlours, cow udders and animal sheds. Some, for example formaldehyde, are used in the production of silage. Disinfectants are also used in non-routine situations to help in the control of infectious disease and are generally applied liberally. Some of the principle disinfectants used in agriculture are chlorine, formaldehyde, phenol (carbolic acid), hydrogen peroxide and caustic soda. These are all highly toxic substances and, although dilution and oxidation will rapidly reduce their potency, their impact upon small watercourses may be severe and include invertebrate and fish kill. Impacts are most likely to occur when disinfectants are used in large quantities for disease control (Bruins & Dyer, 1995).

**Oil**

Pollution involving fuel or oil spillages are usually caused by poor management of delivery, storage or disposal. Most incidents are relatively minor in terms of volume, but the potential impacts on surface waters may be severe due to the physical properties of oil compounds and their toxicity to aquatic fauna and flora. The visual impact of oil pollution on surface waters may be cause for particular concern in rural areas of high recreation or amenity value. Contamination of surface water by oil compounds may disturb or destroy aquatic and semi-aquatic wildlife, including birds, and also affect fish farms through both acute and tainting effects.

**Molasses**

Bulk storage of molasses as animal food is commonplace on farms. Its high BOD poses a significant risk to the water environment if contamination occurs due to poor storage facilities or careless disposal of left-overs and washings.

## 6. Mitigation measures

Measures that may be undertaken to reduce or avoid potential effects from agricultural operations are presented below. The *Code of Good Agricultural Practice for the Protection of Water* (MAFF, 1991) contains appropriate advice, as does a similar code of practice for the protection of soil (MAFF, 1993).

### 6.1 Use of water resources

It is NRA policy to apply the principle of sustainability to water resources and where the impact of abstraction is uncertain, to take a precautionary approach (NRA, 1994d). In order to best protect the water environment the NRA promotes more efficient use of water resources by agriculture.

Agricultural demand on water resources could be reduced if farmers and growers were able to store water when it is available during the winter months, to be used in times of low rainfall. A greater use of trickle irrigation as opposed to spray irrigation would also help to mitigate agricultural impacts on water resources.

## 6.2 Change of land use or land drainage

Where a change in land use results in hard surfacing of a large area, impacts on the flow regime of any nearby watercourse would be avoided or minimised if rainwater was directed either to a dedicated surface water drainage system or to a holding pond with gradual release to a soakaway. Where such change involves the ploughing of established grassland, potential impacts on the water environment may be reduced if ploughing is not undertaken on steep slopes or during the winter months.

The visual impacts of land use change can be reduced by sympathetic design of buildings and the retention of natural features such as mature trees and hedgerows wherever this is possible.

Bank erosion and subsequent deposition of material in watercourses can be reduced if land drainage ditches are seeded with grass or other appropriate plants immediately after excavation (Skaggs *et al*, 1994). It is important that a farmer knows the location layout and outfall points of all sub-surface drainage pipes. A clear indication of field drainage facilities should be included in any farm waste management plan.

## 6.3 Inputs to surface and groundwaters

The most effective mitigation measures with respect to agricultural inputs to the water environment are those which aim to prevent the accidental release of materials or their inappropriate application to land. The NRA has powers to inspect existing premises and comment on plans for proposed developments or land use change in order to provide advice and guidance regarding pollution prevention.

**Organic wastes**
All new or substantially enlarged or reconstructed facilities for the storage of animal wastes and silage must comply with the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations 1991. The Regulations specify a minimum storage capacity for animal slurry and require they are constructed according to BS 5502 Part 50 (1989). Further technical advice is given in the *Code of Good Agricultural Practice* (MAFF, 1991) and guidelines for construction are available (CIRIA, 1992).

In order to minimise the risk of water pollution farmers should also:
- ensure storage facilities are of an adequate size - the NRA is able to give advice;
- ensure slurry stores are sited in an appropriate location - the NRA will offer advice;
- ensure the construction of slurry collection and storage facilities is undertaken by a competent contractor with appropriate experience and knowledge of the Regulations;
- store yard water separately from slurry - this will minimise the volume of slurry to be disposed of;
- prevent entry of rain water or roofwater into any slurry collection or storage facility;
- formulate a farm waste management plan that is able safely to dispose of the predicted quantity of organic waste - detailed advice on such plans may be found in the *Pollution*

*Prevention Manual* (NRA, 1995d) and a free booklet is available (NRA 1994e);
- ensure only responsible contractors are used for waste application to land;
- spread animal waste to land only in accordance with the *Code of Good Agricultural Practice*.

Dairy waste, such as milk, should be handled and disposed of in accordance with the relevant NRA Pollution Prevention Guidelines (NRA, 1995e).

Silage stores must also comply with the 1991 Regulations and should be made on an impermeable base within perimeter drains flowing into an effluent tank. No part of an installation should be within 10 metres of a watercourse. Silo walls should be designed to BS 5502 Part 22 and a silo, tank and drains should be designed to last for 20 years with routine maintenance. Below ground effluent tanks should be designed to last for 20 years without maintenance.

The risk of water pollution from silage liquor is minimised if:
- silage liquor storage tanks are of an adequate capacity;
- rainwater is not allowed to mix with the liquor and overwhelm a store;
- a fluid level alarm is fitted to the liquor store;
- silage storage facilities are regularly maintained.

At the time of writing the Government has indicated it will introduce changes to the 1991 Regulations that will allow farmers to use field heaps and/or non-baled bagged silage for silage making and storage from the end of August 1996 (DoE Press Release 7th June 1996). Government guidance to farmers concerning silage making and storage will be revised at that time. The mitigation measures suggested here will nevertheless still be applicable wherever silage is made or stored close to a watercourse, in order to protect the water environment.

**Pesticides**

The NRA has produced guidelines for preventing pollution of controlled waters by pesticides (NRA, 1993). The Authority recommends that:
- Pesticides should be kept in a locked store, protected against fire and theft. The store must be sited well away from any watercourses, drains, boreholes and areas prone to flooding.
- Closed transfer and mixing systems should be used wherever possible.
- There should be no direct connection between a spray tank and the water supply.
- Unwanted pesticides should be disposed of according to the recommendations provided in the *Code of Good Agricultural Practice* (MAFF, 1991) or the relevant NRA Pollution Prevention Guidelines (NRA, 1993).

**Sheep dip**

Guidance on the design of facilities, dipping and disposal of used dip is provided by the Ministry of Agriculture, Fisheries and Food (MAFF, 1991). The NRA has also produced pollution prevention guidelines for sheep dip (NRA, 1994f).
The NRA recommends that:
- Sheep dip concentrate should be stored safely and in accordance with Health & Safety Executive Guidance.
- Sheep dips be sited on level ground, away from watercourses, springs or land drains.

- Drainage from dipping compounds should be channelled back to dips.
- Spent dip should be disposed of quickly, preferably by a reputable waste disposal contractor. Soakaways are not regarded as a suitable option for the disposal of spent dip (NRA, 1995f).

The NRA will provide advice to farmers on the siting of sheep dips and safe disposal of the used compounds.

## 7. Baseline surveys

A water quality catchment survey may be used to pinpoint actual and potential polluting inputs to surface waters within a defined area. This baseline information can be used as a management tool to assist in the formulation of an impact monitoring strategy within a catchment.

A more detailed baseline study of surface waters adjacent to a potential source of impact should undertake a hydrological survey and chemical/biological analysis of water quality. A river corridor survey and fish survey within the area of interest should be undertaken where the conservation, recreation or fisheries value of local waters is high.

## 8. Monitoring

The monitoring of the impact of agricultural developments or operations may be difficult as farming activities are widely dispersed throughout river catchments, whereas routine water quality monitoring sites are generally confined to major watercourses. The nature of agricultural impacts demands that a monitoring strategy combines a water quality survey with the on-site inspection of farms to observe compliance with the relevant Regulations. Organic farm pollution may be detected and monitored using a biological technique (NRA, 1995g), while national NRA guidance concerning monitoring of agricultural impacts is to be found in the *Pollution Prevention Manual* (NRA, 1995d).

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National Rivers Authority (1994d) *Water: Nature's Precious Resource. An Environmentally Sustainable Water Resources Development Strategy for England and Wales*. HMSO, London.

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*Pollution*. NRA, Bristol.

National Rivers Authority (1994f) *The Prevention of Pollution of Controlled Waters by Sheep Dip*. Pollution Prevention Guidelines No 12, NRA, Bristol.

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National Rivers Authority (1995b) *Water Pollution Incidents in England and Wales - 1994*. NRA Water Quality Series No. 25, HMSO, London.

National Rivers Authority (1995c) Pesticides in Major Aquifers. R & D Report 17, HMSO, London.

National Rivers Authority (1995d) *Pollution Prevention Manual - Pollution Control*. NRA, Bristol.

National Rivers Authority (1995e) *Dairies and Other Milk Handling Operations*. Pollution Prevention Guidelines No. 17, NRA, Bristol.

National Rivers Authority (1995f) *Pesticides in the Aquatic Environment*. NRA Water Quality Series No. 26. HMSO, London.

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF KENNELS, CATTERIES AND STABLES

## 1. Introduction

This guidance note seeks to identify the potential impacts of kennels, catteries and stables upon the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such developments. The NRA has an interest in these developments due to its responsibility for protection of the water environment, particularly with respect to the control of pollution of groundwater and surface waters.

Activities associated with kennels, catteries and stables that may impact upon the water environment are similar to those inherent in a livestock farming operation (NRA, 1992). That is, the cleaning of animal housing and yards, feeding of animals, waste storage and waste disposal. The intensity of impact from kennels, catteries or stables is likely to be less than from an agricultural livestock facility but may nevertheless present a localised threat to surface waters.

## 2. Development control

In most cases a proposed development intended for use as kennels, catteries or stables is likely to fall under the Town and Country Planning system and will therefore require consent from a local planning authority.

Planning consent may not be required if the proposed development lies within agricultural premises, as many agricultural activities are exempt from local authority development control. Permitted development rights are given for a wide range of agricultural operations such as buildings, drainage works and excavations by the Town and Country Planning (General Permitted Development) Order (SI 1995 Nº 418).

It is not the purpose of this guidance to determine whether or not planning permission would be required for a particular structure and a potential developer should seek advice from the local planning authority.

## 3. Environmental Assessment

The development of land for use as kennels, catteries or stables are not identified in the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) as having to a mandatory or discretionary requirement for Environmental Assessment (EA). Nevertheless, if a threat to water resources is apparent this constitutes a material planning consideration and the NRA, as consultee to such proposals, may request environmental information concerning the development. The NRA, as regulatory authority, may also request environmental information in order to determine an application for effluent discharge to surface waters. An EA may be the most appropriate method for collation and presentation of such information. This could follow the guidelines prepared by the Department of the Environment (DoE, 1995) in relation to development projects.

## 4. NRA consents

The NRA has a responsibility under the 1991 Water Resources Act for the regulation of discharges to controlled waters. These include groundwater and all coastal or inland waters, including lakes, ponds, rivers, streams, canals and ditches. It is an offence under this legislation to cause or knowingly permit:

- any poisonous, noxious or polluting matter or any solid waste matter, or
- any trade effluent or sewage effluent,

to enter into controlled waters. No offence is committed if the discharge is made in accordance with a consent granted under Section 85 of the Act by the NRA.

If it is proposed to discharge any effluent from the operation of kennels, catteries or stables, such as yard or shed washings or animal excreta, into a watercourse or other controlled water body, NRA consent would be required.

## 5. Potential impacts

The impacts of construction activities associated with the erection of structures for animal housing are not dealt with here. Guidance for EA of such issues is provided by Guidance Note 1 of this series (General Construction).

Storage and disposal of animal faeces and urine represent the primary threat to the water environment from kennels, catteries or stables. Although in the case of catteries or kennels a relatively small daily quantity of waste may be involved, if this should be collected and stored on site, a large amount of polluting material may accumulate. This may be compounded by the presence of organic bedding material such as sawdust or wood chippings. Where a development consists of stables the quantity of animal waste may be considerable. Other potential sources of impact on the water environment are the disposal of animal carcasses, use of cleaning or sterilising agents within animal housing units and, in the case of stables, puddling of the ground surface.

### 5.1 Hydrology

An impermeable covering of a large area of ground surface with animal housing units and exercise yards may result in significant alteration to existing surface water runoff. If rainwater is allowed to flow overland to a watercourse, land surface erosion may occur. This may be exacerbated where land is used for exercise of horses as the combination of localised erosion and intensive surface runoff from an impermeable surface may cause gullies to form. Such runoff may also cause localised erosion of a stream bed or bank where it enters a watercourse.

An increase in the intensity of local flooding may be possible in periods of high rainfall due to rapid runoff of surface water from covered areas. Although this is likely be a highly localised impact, it may nevertheless cause significant additional stream bed and bank erosion.

## 5.2 Surface water quality

A common characteristic of all organic wastes is their high biochemical oxygen demand (BOD) and the primary impact of these pollutants upon surface waters is therefore depletion of dissolved oxygen.

Wastes such as cat or dog faeces contain a relatively high concentration of ammonia. Excess total ammonia is the most common cause of non-compliance with the EC Freshwater Fish Directive (78/659/EEC). The nitrate and phosphate components of organic waste act as artificial nutrients within any watercourse and may affect aquatic wildlife.

Animal waste and bedding material from kennels, catteries or stables often contain a large quantity of inert material and in water this, along with the degradation products of microbial decomposition, is present as suspended solids. These may increase turbidity and upon settling out physically alter the sediment characteristics of a stream. Local aquatic habitats may undergo significant change if they become covered with sediments. As microbial decomposition continues within such deposits, a stream bed can become covered with anoxic (oxygen-free) mud, which may produce methane.

Animal wastes and the decomposition products of animal carcasses will usually contain micro-organisms which may be pathogenic, such as faecal *Streptococci* and coliforms. Contamination of a watercourse by these disease agents may result in a direct threat to human health and may render the water unfit for use as a supply source.

Increased erosion associated with rainwater runoff from large covered areas may cause increased water turbidity and sediment load.

## 5.3 Wildlife

Contamination of surface waters by animal wastes may result in a reduction in numbers and decreased diversity of aquatic fauna, due primarily to de-oxygenation of the water. Where pollution is severe, only a very restricted invertebrate fauna may be present. Fish are unlikely to be seen in such conditions. Excessive algal growth due to nutrient enrichment may occur which can be detrimental to aquatic vegetation. Where water is polluted by organic wastes "sewage fungus" (a mixture of algae and bacteria) is often found.

Where organic waste contamination is abrupt, after rupture of a waste storage tank for example, an extensive invertebrate and fish kill could be expected in the immediate locality and some distance downstream. Where low-level contamination takes place over a period of time, the density and composition of the aquatic community, including the natural fish population, are likely to change.

The presence of ammonia is detrimental to wildlife within surface waters. It is highly toxic to aquatic animal life and may dramatically affect fish populations. This is also the case for disinfectants and sterilising agents.

The severity of ecological impact caused by animal waste contamination will depend upon the degree of dilution that has occurred within the surface waters.

An increased intensity of flooding after rainfall may destabilise an aquatic community. Erosion and/or siltation resulting from rapid surface runoff may cause a change to a stream bed habitat and alter the species composition of the benthos. Erosion is likely to inhibit the presence of benthic algae and invertebrates, while siltation may allow only those animals adapted to living in mud and silt to remain. Increased turbidity associated with land, bank or bed erosion may inhibit plant growth by light attenuation and directly injure fish by abrasion to the gills. Such turbidity may also alter fish behaviour. Sediment deposition within a watercourse resulting from additional land erosion may disturb fish spawning gravels and thereby reduce the fisheries value of a stream.

## 6. Mitigation measures

Mitigation measures to avoid or reduce impacts to the water environment caused by kennels, catteries or stables should aim to prevent the entry of organic wastes to surface waters and to control rainwater run-off from a site.

- Horse manure stores should be roofed to prevent rainwater access to the waste and avoid creating surface run-off of polluting liquid.
- Wherever possible, kennels and catteries should drain to the public foul sewerage system. A developer may be able to negotiate with a sewerage undertaker that yard and shed washings be discharged to mains drainage; a charge is likely to be made for this service.
- When no mains sewerage facilities are available, small animal wastes, yard and shed washings should be kept separate from clean rainwater to minimise volume and collected in a sealed storage facility. This should be regularly emptied by a registered waste disposal contractor.
- Rainwater from roofs and clean yards should discharge either to a public drainage system, a soakaway or via pipeline/ditch to a watercourses. It should not be allowed to flow uninhibited over the land surface.

## 7. Baseline surveys

Baseline information necessary for EA of kennels, catteries or stables will comprise a chemical and biological survey of any adjacent watercourse. In areas of high conservation interest a localised river corridor survey may be appropriate.

## 8. Monitoring

A developer should periodically check the integrity of any animal waste storage facility. Where a kennels, cattery or stables are situated within an area where surface waters have a high conservation or recreation value it may be necessary to monitor water quality adjacent to a development by regular chemical or biological analysis.

## 9. References and guidance

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF INTENSIVE LIVESTOCK/POULTRY UNITS

## 1. Introduction

This guidance note seeks to identify the potential impacts of intensive livestock and poultry units on the water environment. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of proposed new developments of this type. The NRA has an interest in intensive livestock and poultry farming owing to its statutory responsibilities with respect to the protection of water resources and the conservation of the aquatic environment.

The assessment of impacts on the water environment caused by general agricultural activities is described in Guidance Note 49 of this series. This note concentrates upon the potential impact of intensive stock farming and poultry units only, as these developments may require a formal Environmental Assessment (EA).

Pigs, chickens and turkeys are most commonly reared under intensive conditions. This practice creates a potential risk of water pollution. Water pollution from pig and poultry farming comprise approximately 9% of national agricultural incidents and pig farming alone accounted for 14% of Category 1 incidents in 1994 (NRA, 1995a). Other stock are also held in intensive units by modern farming practice. Dairy herds, which used to stand in straw-bedded housing when not grazing, are often now kept in intensive units of up to several hundred animals. The rearing of veal calves is also undertaken on an intensive basis.

This guidance note is applicable to all intensive livestock and poultry units. It identifies major potential impacts on the water environment associated with such developments and indicates mitigation measures that can be used to avoid or reduce those impacts. It should prove useful to developers who need to compile an EA, operators who wish to minimise the risk of causing pollution and NRA staff engaged in water quality monitoring and protection duties.

## 2. Development control

Many agricultural developments are exempt from local authority development control under the Town and Country Planning system. Permitted development rights are given for a wide range of agricultural operations such as buildings, drainage works and excavations. There are some limitations to these rights however. Under the 1995 Town and Country Planning (General Permitted Development) Order (SI 1995 Nº 418), the erection or alteration of structures for the accommodation of livestock or storage of slurry does not possess permitted development rights if the ground area covered would exceed 465m$^2$ or the structure would lie within 400m of non-agricultural dwellings or other buildings.

Where a development that would otherwise possess permitted development rights is identified in the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI Nº 1199) as requiring EA were it subject to development control, those rights are removed by SI 1995 Nº 418. Therefore, development consent may be required for pig and poultry rearing facilities, depending on their size, as these are identified in the 1988 Regulations (see next section). Prospective developers are advised to seek an opinion from their local planning authority regarding the requirement for development consent at an early stage in project planning.

## 3. Environmental Assessment

New developments intended for pig and poultry-rearing are presently designated as Schedule 2 projects under the 1988 Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) and may require a formal EA if they are likely to have a significant effect upon the environment by virtue of their size or location. It is for the local planning authority to decide if an EA should be undertaken. The conduct of an EA and subsequent preparation of an Environmental Statement should follow the guidelines prepared by the Department of the Environment (DoE, 1995).

A draft Directive issued by the European Commission (CEU, 1994) has placed in Annex I (for mandatory EA) all installations for the intensive rearing of poultry and pigs above certain thresholds. The draft Directive also places all intensive stock farming within Annexe II (for discretionary EA) but these changes are not incorporated into UK law at the time of writing.

Even where a formal EA of an intensive livestock or poultry farming development is not requested by a local planning authority, it may prove worthwhile to undertake some form of assessment. The NRA is the competent authority that determines consent for discharges to the water environment and also enforces Regulations concerned with the storage of agricultural wastes. As such it may request environmental information concerning any discharge or waste storage facility. Such information may be necessary to enable the NRA to meet its statutory obligations with respect to the protection of the water environment, particularly in regard to the control of pollution of surface waters. An EA may provide the most appropriate means for a developer to collate relevant environmental information.

## 4. NRA consents

Under the 1991 Water Resources Act the NRA is responsible for the regulation of discharges to controlled waters. These include groundwater and all coastal or inland waters, including lakes, ponds, rivers, streams, canals and ditches. It is a criminal offence to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste matter, or any trade effluent or sewage effluent, to enter into controlled waters. No offence is committed if the discharge is made in accordance with a consent granted under Section 85 of the Act by the NRA. Section 85 does not cover discharges to land but the NRA may also prohibit or place conditions on such discharges under Section 86. This power is limited to discharges "from a building or from any fixed plant".

The disposal of agricultural wastes is presently exempt from any specific controls other than those relating to their storage. The 1991 Act and the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations 1991 set minimum standards for keeping and handling silage, effluent, slurry and agricultural fuel oil in order to prevent pollution by these substances. The NRA is responsible for enforcement of these Regulations. New, substantially enlarged or substantially reconstructed installations must meet specified criteria and the NRA should be notified at least 14 days before an installation is brought into use. Dirty water, such as that from yard washings, is defined as slurry within the 1991 Regulations. Facilities in existence before 1st March 1991 may be exempted from these standards but the NRA can ask for them to be improved if there is a significant risk of causing water pollution.

The Water Resources Act also contains powers to designate water protection zones and Nitrate Sensitive Areas proposed by the NRA, within which activities likely to result in water pollution are restricted.

Measures to extend statutory waste management controls to include certain types of agricultural waste are to be laid before Parliament during 1996.

## 5. Major potential impacts

Impacts on surface and groundwaters from intensive stock and poultry units are most likely to be caused by poor collection, storage or disposal of animal wastes. These wastes may take the form of solid manure from poultry battery, broiler or deep-litter systems, or a semi-solid to liquid slurry from beef or pig housing where little bedding material is used. Impacts on the water environment may also result from storage of silage, animal feed, fuel oil, disinfectants or pesticides, cleaning or disinfecting of animal units, pesticide use, heating and ventilation of sheds and disposal of poultry carcasses.

The cumulative impact of organic or any other pollutants within a river catchment is crucial to water quality. An EA of any intensive livestock or poultry facility should examine its potential impact on the water environment in the context of other existing and potential future pollution sources.

### 5.1 Construction

The hard surfacing of yards and erection of buildings may result in a significant alteration to existing surface water runoff. If rainwater is discharged directly or indirectly to a watercourse then land surface or river bank erosion may occur and increase stream turbidity. Loose excavated material on the site during construction of buildings and storage facilities may also be washed to a watercourse. An increase in the intensity of flooding is likely in periods of high rainfall due to the rapid runoff of water from roofed buildings and surfaced areas.

Another guidance note in this series (Guidance Note 1. General Construction) will assist in the identification of construction impacts on the water environment.

## 5.2 Operation

The operation of intensive farming units involves the collection and disposal of large quantities of animal wastes. The biochemical oxygen demand (BOD) of animal wastes is very high. Farm yard washings commonly have a BOD of 1000-2000mg/litre, cattle slurry of 10,000-20,000mg/litre and pig slurry 20,000-30,000mg/litre (this may be compared to that of raw domestic sewage of 300-400mg/litre). In addition, animal wastes contain a high proportion of nitrate, phosphate and ammonia, and may also be contaminated with pathogenic micro-organisms. Such wastes are very harmful to the water environment and they should not have any opportunity to enter either surface or groundwaters in an uncontrolled manner.

Where intensive animal husbandry is undertaken, the storage and use of animal feed, silage, detergents, disinfectants and fuel oil in large quantities presents a risk of damage to the water environment. This may occur through leakage, spillage or poor practice and result in contamination of surface water and/or groundwater. Silage liquor is particularly harmful to water as it has a very high BOD of 30,000-80,000mg/litre.

### 5.2.1 Surface water quality

Poor design of facilities for the collection, storage and disposal of animal wastes or the storage of silage or chemicals may result in the entry of contaminants to local surface waters. The risk of such an event may be compounded by bad operational practice. Pollution of surface waters may result from:

- the direct discharge of yard and shed washings to a watercourse;
- unseparated rainwater and effluent collection/drainage systems;
- discharge of roofwaters contaminated with dust from ventilation systems;
- inadequate or leaking waste collection pits;
- leaking slurry tanks, lagoons or silage/chemical stores;
- overflow from tanks/lagoons of an inadequate volume;
- excessive spreading of slurry or manure to adjacent agricultural land;
- spreading of animal waste upon frozen, compacted or steeply sloping ground.

When organic material enters surface waters the potential consequences to water quality include de-oxygenation of waters, increased suspended solids and turbidity, and nutrient enrichment. Effluent from animal units might also contain harmful micro-organisms. Where surface water is polluted with bacteria or virii, it may become unfit for use as a public supply source and could pose a direct threat to human health. These impacts may be intensified by the presence of other contaminants such as fuel oil, animal feed, disinfectants, pesticides and detergents.

Where fuel oil is used as a heating fuel for animal units, the related pipework is often extensive where it feeds to heat generators. In such situations an opportunity for chronic, undetected leakage or acute spillage exists, with the possibility of subsequent contamination of surface water.

Disinfectants and pesticides are used extensively in intensive livestock and poultry units. These compounds are usually highly toxic and if they should enter surface water through leakage, spillage or careless handling, are likely to cause great harm to aquatic wildlife and may pose a threat to drinking water supplies (Bruins & Dyer, 1995; NRA, 1995b).

Water quality may also be adversely affected by contaminated runoff from roads and vehicle parks associated with the transport requirements of animal units.

### 5.2.2 Groundwater quality

Contamination from animal waste may enter groundwaters from the same sources likely to pollute surface waters. This includes yard and shed washings, slurry or silage storage facilities and slurry spreading. The field spreading of slurry or manure carries particular risks for groundwater because of the large surface area available for leaching processes and the regular application usually involved. Poultry litter has the greatest potential threat to groundwater due to its high nitrate and phosphate content and frequent contamination with pathogenic micro-organisms (Phillips & Hartung, 1995).

All animal wastes are high in nitrogen content and poultry manure in particular has a high proportion of nitrogen in ammonium and uric acid form. These are quickly converted to nitrate in the soil and field application of any animal slurry in autumn or early winter can result in a high proportion of the nitrate being leached to groundwaters through the winter months. Nitrate contamination of groundwater may also occur whenever animal slurry is spread in excessive quantity.

It is possible that groundwaters could also be contaminated by leakage of agricultural chemicals or fuel oil that may be stored on a site.

### 5.2.3 Aquatic ecology

Contamination of surface waters by animal wastes may result in a reduction of invertebrate and fish numbers and/or diversity, due primarily to de-oxygenation of the water. Where pollution is severe, only a very restricted invertebrate fauna will be present. Excessive algal growth due to nutrient enrichment may occur and "sewage fungus" (a mixture of algae and bacteria) is often found. An increase in suspended solids can cause a reduction in aquatic plant growth through absorption of light and direct damage to invertebrates by a smothering effect as they settle. Suspended solids may also cause harm to fish by abrasion of their gills. Settling out of organic material in a watercourse may lead to profound change in the benthic community and lead to anaerobic conditions within stream sediments.

Where contamination is abrupt, after rupture of a slurry storage tank for example, extensive invertebrate and fish death could be expected in the immediate locality and for some distance downstream. Where low-level contamination takes place over a period of time, the density and composition of the aquatic community, including the natural fish population, is likely to change.

As livestock excreta contains ammonia, this may be present in waters contaminated by animal wastes. Poultry waste in particular contains a high proportion of this compound. It is highly toxic to aquatic animal life and may destroy fish populations.

Contamination of surface waters by fuel oil, disinfectants or pesticides is likely to have a severe impact on aquatic ecology. As these compounds are toxic, an acute pollution incident from chemical spillage or careless disposal could result in localised destruction of all aquatic plants or animals, including fish. Secondary impacts may include injury to wildfowl and other vertebrates that feed in the aquatic environment.

The severity of ecological impact caused by organic or chemical contamination from intensive livestock or poultry units will depend upon the degree of dilution that has occurred within the surface waters.

### 5.2.4 Recreation

Deterioration of water quality, particularly that caused by sudden pollution by animal wastes may adversely affect the potential use of surface water for recreation. Opportunity for fishing may be reduced and offensive odour or poor visual appearance may restrict activities such as boating and swimming.

## 6. Mitigation measures

Various mitigation measures should be considered in order to avoid potential impacts that may arise through the collection, storage and disposal of animal waste, and the storage and use of fuel oil or chemicals. Where unavoidable impacts are likely to occur, they may be reduced in intensity by the adoption of good system design and good practice.

### 6.1 Yard and shed washings

A developer may be able to negotiate with a sewerage undertaker to discharge yard and shed washings to mains drainage if a premises is connected to the public foul sewer network. A charge is likely to be made for this service.

When no mains sewerage facilities are available, yard and shed washings should be kept separate from clean rainwater to minimise volume, and collected in an adequate storage facility. It may then be sprayed onto land. Advice upon the safe collection and disposal of dirty water is provided in a *Code of Good Agricultural Practice for the Protection of Water* (MAFF, 1991).

Ventilation for poultry units should make use of side vents rather than roof vents. This will avoid rainwater contamination by animal feed and dust that accumulates near vents. Additional protection for the water environment can be provided by the use of a soakaway for rainwater drainage.

### 6.2 Storage of solid manure and slurry

Within farm yards, solid manure should be stored in permanent, impermeable storage facilities and spread to land in accordance with the *Code of Good Agricultural Practice*. The storage units should incorporate a liquid run-off collection system so liquid waste does not run to surface waters. This liquid is treated as slurry under the 1991 Regulations for the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) and must be collected and stored as such. Solid manure should only be stored in field heaps where there is no risk of run-off polluting water, i.e. away from field drains, watercourses, springs, wells or boreholes.

The 1991 Regulations prescribes minimum standards for the construction of slurry stores. Facilities should conform with BS 5502 Part 50: *Buildings and Structures for Agriculture* (BSA, 1989). The most appropriate design and construction of a slurry store will depend upon its location and the NRA is able to undertake a site inspection and offer advice whenever the construction of an earth-banked store is proposed.

The 1991 Regulations require that slurry stores be of adequate volume to hold at least four months supply of slurry unless a safe year-round disposal system is available. Some intensive farming units will need larger storage facilities and this requirement should be carefully assessed. It is advisable that rainwater or other clean water is prevented from flowing into any slurry store as this may cause flooding of the facility.

It is preferable that slurry storage facilities situated in the vicinity of a watercourse possess a surrounding retaining wall or bund of sufficient capacity to contain all slurry from the tank structure should it develop a catastrophic leak.

### 6.3 Farm waste disposal

Solid manure may be used safely as a field fertiliser when applied at the rates suggested by the *Code of Good Agricultural Practice for the Protection of Water*, as the risk of causing water pollution is then low. However, manure should not be spread to high risk areas as identified in the *Code of Practice*. Particular care should be taken not to apply poultry manure at a rate above that suggested. Nevertheless, surface runoff can transport manure if rain falls immediately after application and it should not be spread within 10 metres of a watercourse or 50 metres of a spring, well or borehole that supplies water for human consumption.

Animal slurry should be used with care as a field fertiliser and only upon certain areas of a farm, in appropriate concentrations and conditions. Detailed advice is provided in the *Code of Good Agricultural Practice*. This includes suggested application rates for slurry and the NRA will seek to ensure that slurry disposal to land follows those guidelines.

A farm waste management plan should be devised in consultation with the NRA and should indicate those areas of land not suited for slurry application at any time. This may include areas where land drains exist, particularly if they combine to form a single outlet to a watercourse, as contamination is then concentrated even where spreading is at a low rate. It is NRA policy to advise local planning authorities to refuse permission for proposed agricultural developments which could lead to the disposal of slurries to land unless it is satisfied that sufficient, suitable land is available for disposal purposes (NRA, 1992).

Poultry carcass disposal should be to an on-site incinerator or or via removal by a licensed disposal contractor.

## 6.4 Use and storage of other materials

Silage should be stored according to the 1991 Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations. Stores should be sited on an impermeable base within perimeter drains flowing into an effluent tank. Silage liquor storage tanks should be of an adequate size and should not be open to rainwater. No part of an installation should be within 10 metres of a watercourse. Silo walls should be designed to BS 5502 Part 22 and a silo, tank and drains should be designed to last for 20 years with routine maintenance. Below ground effluent tanks should be designed to last for 20 years without maintenance.

Agricultural fuel oil should also be stored in accordance with the 1991 Regulations. Disinfectants and detergents must be stored in safe conditions and used only in the concentration and manner specified by the manufacturer.

Pesticides should be kept in a locked store, protected against fire and theft. The store must be sited well away from any watercourses, drains, boreholes and areas prone to flooding. Unwanted pesticides should be disposed of according to the recommendations provided in the *Code of Good Agricultural Practice* (MAFF, 1991) or the relevant NRA Pollution Prevention Guidelines (NRA, 1993).

## 7. Baseline surveys

A prime consideration in EA of any intensive livestock operation is an assessment of any existing field application of slurry. Proposals for intensive livestock units are only environmentally viable if sufficient capacity for land disposal of animal wastes can be demonstrated. Historical data concerning slurry application to land is desirable for EA.

Where surface or groundwater is used for potable supply, or surface waters have a high amenity or recreational value, detailed baseline information will be required. Surveys should be directed at the collection of data to enable the assessment of both point source and diffuse impacts of an intensive livestock/poultry unit operation. It is recommended that the following surveys are undertaken:

- hydrological survey to assess flow rates and dilution potential of any watercourse;
- river corridor survey of area adjacent and downstream to the unit;
- geomorphological survey of stream sediments;
- chemical and biological water quality assessment;
- survey of aquatic flora, fauna and physical features.

A survey of fish populations and water-based recreation opportunities may be helpful to any assessment in areas where these are seen as important community resources.

## 8. Monitoring and Audit

Monitoring of an intensive livestock or poultry unit should be undertaken by both the operator and the NRA. Farm visits can be used by NRA staff as an opportunity to build good relationships with farmers as this may prove mutually beneficial in dealing with problems as they arise.

An appropriate monitoring strategy should be designed and implemented by the operator to confirm the predicted impacts of any intensive livestock or poultry unit on the water environment. Regular inspections should be made of all waste storage and disposal facilities, silage stores and feed/chemical stores to ensure their integrity and efficient operation. The effectiveness of mitigation measures should be assessed.

Regular farm visits should be undertaken by NRA personnel. The objective should be to ensure that the requirements of the Control of Pollution Regulations are being met. Where possible, site inspections should seek to confirm the extent of manure and slurry application to land, particularly in autumn and winter months. A legal requirement to record field application of slurry may be introduced by a Section 106 condition of planning consent. Visual inspection of a watercourse during visits should reveal point sources of pollutants where this has occurred.

Routine biological and chemical river water sampling programs undertaken by the NRA may be modified to include several sampling sites downstream of any intensive livestock or poultry unit. These data may be used to assess impacts upon water quality. It is possible that a new rapid biological assessment technique developed to detect organic pollution of surface water by farms (NRA, 1995c) could be used to confirm predicted impacts and for routine monitoring. The *Pollution Prevention Manual* (NRA, 1995d) is likely to be a central reference for pollution monitoring.

## 9. References and guidance

British Standards Association (1989) BS 5502 Part 50: *Buildings and Structures for Agriculture. Code of Practice for Design, Construction and Use of Reception Pits and Storage Tanks for Slurry.*

Bruins, G. & Dyer, J.A. (1995) Environmental considerations of disinfectants used in agriculture. *Revue Scientifique et Technique De L'Office International Des Epizooties* **14** (1): 81-94.

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Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide.* HMSO, London.

Ministry of Agriculture, Fisheries and Food (1991) *A Code of Good Agricultural Practice for the Protection of Water.* MAFF, London.

National Rivers Authority (1992) *Policy and Practice for the Protection of Groundwater.* NRA, Bristol.

National Rivers Authority (1993) *The Prevention of Pollution of Controlled Waters by Pesticides.* Pollution Prevention Guidelines No 9, NRA, Bristol.

National Rivers Authority (1995a) *Water Pollution Incidents in England and Wales - 1994.* NRA Water Quality Series No. 25. HMSO, London.

National Rivers Authority (1995b) *Pesticides in the Aquatic Environment.* NRA Water Quality Series No. 26. HMSO, London.

National Rivers Authority (1995c) *Detection of Organic Farm Pollution: the use of a Biological Technique for the Detection and Monitoring of Farm Pollution.* R & D Report 19. NRA, Bristol.

National Rivers Authority (1995d) *Pollution Prevention Manual - Pollution Control.* NRA, Bristol.

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# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF TIPPING/DUMPING

## 1. Introduction

This guidance note seeks to identify the potential impacts of tipping and dumping upon the water environment. It is intended to act as a general scoping brief for environmental assessment (EA) of such activities. The National Rivers Authority (NRA) has an interest in tipping and dumping due to its general environmental responsibilities, particularly with respect to the protection of surface and groundwater quality and flood defence.

The EA of disposal facilities that deal with controlled and special wastes is described in NRA Guidance Note 20. This note identifies potential impacts arising from some unauthorised types of waste disposal. Tipping refers to "fly tipping", or the unloading of diverse material in or adjacent to controlled waters (rivers, lakes, canals, streams etc.) at some distance from the source of the waste. Dumping refers to the unauthorised placing of material in or near controlled waters directly from the source of the waste.

Fly tipping in or adjacent to controlled waters is seen primarily in rural areas. Unauthorised disposal of a wide range of development materials, such as topsoil, cement, lime, rubble etc. takes place in this manner. Road planings (tar macadam) and old car bodies are often tipped in or adjacent to a watercourse or other water body. Some fly tipping of agricultural wastes, such as sheep carcasses, empty pesticide containers etc., also occurs. In urban areas the dumping of waste material directly from industrial, commercial or residential premises constitutes a threat to the water environment.

## 2. Development control

Unauthorised tipping or dumping of wastes obviously does not fall under development control consenting procedures. Diverse legislation may be used to prosecute the person(s) responsible for unauthorised tipping/dumping, including civil action by an injured party and action under the Public Health Acts by a local authority if domestic property is flooded.

The NRA can take legal action against unauthorised tipping/dumping under Section 23 of the Land Drainage Act 1991, or Section 109 of the Water Resources Act 1991, but proceedings via a Magistrates Court must commence within six months of the illegal action if the person responsible is to be convicted (NRA, 1994a).

## 3. Environmental Assessment

As an illegal activity, no requirement for EA could apply to tipping or dumping and no person conducting such operations would be likely to welcome an EA of their activities. However, inclusion of tipping and dumping impacts in an EA of a development proposal may be appropriate if a development is likely to create conditions, such as easy vehicular access to controlled waters or riparian habitat, where unauthorised waste disposal may take place.

## 4. NRA consents/licences

No NRA licences or consents are applicable to unauthorised tipping or dumping of wastes.

## 5. Major potential impacts

Potential major impacts on the water environment resulting from tipping/dumping are those likely to affect the geomorphology of a watercourse, its potential to flood, surface and groundwater quality, wildlife and visual amenity.

### 5.1 Geomorphology

Where solid material is tipped or dumped into a watercourse it may constitute an obstruction to flow. Such modification of a flow regime may cause increased bank and/or bed erosion with subsequent downstream deposition of sediments. If the deposited material is fine grained, such as topsoil, cement etc., it may itself directly cause increased turbidity and downstream sedimentation.

If heavy or water-absorbent material is tipped adjacent to any water body it may result in bank failure with consequent impacts upon water flow, erosion and sediment deposition.

### 5.2 Flood defence

Where tipped or dumped material directly obstructs river flow it may increase the risk of localised flooding and also the duration of flood. This may be particularly true of large objects such as car bodies or solid building material, as natural detritus may collect around them and further hinder river flow.

Material tipped close to a watercourse can obstruct the flood storage capacity of the flood plain and interfere with free lateral and downward movement of floodwaters. Water level upstream may be raised and flow velocities immediately downstream increased by any such obstruction. Tipped material may also obstruct river maintenance and flood defence works.

### 5.3 Water quality

The potential impact of tipping/dumping upon surface or groundwater quality will depend upon the composition of any offending material. The range of possible contaminants is too great to enumerate here but of particular concern are:

- building materials such as cement, plaster and lime that can dramatically alter the acidity of any surface waters,
- road planings comprising tar macadam and car bodies/engines that will contain toxic petroleum compounds,
- organic material from agricultural operations, such as animal waste or animal carcasses, that are likely to contain pathogenic organisms and may increase the localised biochemical oxygen demand (BOD) of water.

Any pollution of surface waters caused by tipping or dumping is of concern to the NRA, but would be particularly serious where an abstraction point for potable water downstream, or if recreational activities where humans are likely to come into contact with water took place nearb. Pollutants that enter surface waters can also percolate into groundwater. This could result in contamination of an adjacent aquifer used for potable water abstraction.

### 5.4 Wildlife

Tipping/dumping of material in or adjacent to controlled waters is likely to cause direct destruction of aquatic and/or riparian wildlife habitat. Indirect impacts on wildlife may occur as a result of increased bed or bank erosion, caused by change in river flow, and downstream sedimentation. Aquatic plants and invertebrates may be displaced by either erosion or deposition and fish spawning grounds may be damaged.

Any adverse change in water quality will affect aquatic life. Compounds leached from tipped or dumped material that are directly toxic to wildlife may cause extensive invertebrate and fish kill. More subtle contamination, such as that causing a change in pH of water, may also have a dramatic impact on plant and animal communities. Where tipping of topsoil or agricultural waste causes organic pollution, the associated high BOD could result in excessive algal growth and depletion of dissolved oxygen, both of which are inimical to aquatic wildlife.

### 5.5 Landscape

Tipping or dumping of waste in or close to a watercourse is likely to have a adverse impact on the visual amenity of the water environment and the wider riparian landscape. This may be most noticeable in rural areas, where tipping often occurs, and may affect the potential for tourism and other recreational activities associated with surface waters.

## 6. Mitigation measures

In respect of fly-tipping, there must be vehicular access to a relatively remote stretch of lake shore, river or riparian area in order for this activity to occur. Mitigation measures to prevent tipping need to address this issue.

- New developments should be designed to reduce unauthorised access. Some design solutions are suggested by the Construction Industry Research and Information Association (CIRIA, 1994).
- It is preferable that little-used private roads that pass close to surface waters be secured by locked gate or chain to prevent unauthorised vehicle access where this is practicable. New developments may wish to adopt such a measure for greater security.
- Sections of a watercourse or other water body presently used for unauthorised waste disposal should be securely fenced. This should also apply to areas where a new development will provide vehicular access to remote surface waters.
- Where a new development will create road access to any controlled waters, it should include planting of trees and bushes along the route to prevent direct vehicle access to the bank or shore.

Dumping of material into or nearby controlled waters is difficult to mitigate against. Education of industrial and commercial operators and riparian residents concerning the need to protect the water environment and the penalties that may be incurred by dumping would appear to be the only practicable measures. In urban or semi-urban areas where the water environment provides a valuable recreational and amenity resource, such education is particularly important.

## 7. Baseline surveys

A river catchment management plan comprises the best means of identifying areas of river and riparian habitat presently used for tipping and dumping. Once identified, appropriate preventative action may be taken. A catchment plan may also be able to pinpoint areas of river vulnerable to this activity. River inspections should be used as a means of gathering data on tipping and dumping sites and vulnerable locations.

## 8. Monitoring

River inspections provide a means by which tipping and dumping can be monitored. If such information is collated on a catchment basis, it should assist planning and implementation of mitigation measures to reduce the occurrence of such activities.

## 9. References and guidance

Construction Industry Research and Information Association (1994) *Dealing with Vandalism - A Guide to the Control of Vandalism.* CIRIA, London.

National Rivers Authority (1992) *Working at Demolition and Construction Sites.* Pollution Prevention Guidelines 6, NRA, Bristol.

National Rivers Authority (1994a) *Flood Defence Technical Liaison Manual: Guidelines for Land Drainage Consenting & Planning Liaison.* NRA, Severn-Trent Region.

National Rivers Authority (1994b) *Preventing Pollution on Industrial Sites.* Pollution Prevention Guidelines 11, NRA, Bristol.

National Rivers Authority (1994c) *Works In, Near or Liable to Affect Watercourses.* Pollution Prevention Guidelines 5, NRA, Bristol.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CAMPING AND CARAVAN SITES

## 1. Introduction

This guidance note seeks to identify the potential impacts of camping and caravan sites upon the water environment. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority for environmental impact studies of such developments. The NRA has an interest in camping and caravan sites owing to its statutory responsibilities under the 1991 Water Resources Act (NRA) with respect to the protection of water quality and flood defence. In addition, the NRA lays down a general duty for the NRA to promote the recreational use of inland and coastal waters and associated land.

As camping and caravan sites (hereafter referred to as campsites) are commonly situated in rural areas of high amenity value with no access to a mains sewerage system, it is possible that sewage disposal may cause adverse impacts on surface water quality. In any area where surface waters are used for amenity and recreation this would be a matter for concern. Such impacts are usually localised and on a small scale, but in regions used extensively for recreational activities, the cumulative impacts on surface water quality of several or many camping grounds may be severe. Campsites may also impact on other aspects of the water environment and may pose a particular problem where multiple developments are situated in flood risk areas.

Sewage disposal facilities of campsites may take the form of a septic tank, cesspool or a package sewage treatment plant. Guidelines for EA of septic tanks and cesspools are provided in Guidance note 54. With respect to impacts on water quality, this note examines the use of package sewage treatment plants by campsites.

A package treatment plant is essentially a small sewage treatment works constructed from prefabricated components. Three types are commonly used: activated sludge units, extended biofiltration units and rotating contactors, which are all based on aerobic oxidation of sewage. All require regular maintenance for effective operation (Payne & Butler, 1993) and usually discharge effluent to a soakaway, a sub-surface irrigation field or a watercourse. The effluent from a package plant is normally suitable for discharge directly to a watercourse. Design and construction criteria for package sewage treatment plants are provided by BS 6297 *Code of Practice for Design and Installation of Small Sewage Treatment Works and Cesspools.*

## 2. Development control

The establishment of camping and/or caravan sites and associated facilities requires local authority planning consent under the Town and Country Planning Act 1990 (as amended). In addition, planning officers are empowered under the Building Regulations 1991 to ensure such development meets certain criteria regarding the provision of services, fittings and equipment. This includes specifications for package sewage treatment plants. However, soakaways and subsurface irrigation systems serving septic tanks and small sewage treatment works are not under the control of these Building Regulations.

The NRA is not a statutory consultee for campsite developments. Nevertheless, both the potential risk to flood defence and the presence of any sewage treatment facility which may pollute surface or ground water supplies are material planning considerations and in such cases the NRA should be consulted at the planning application stage.

### 3. Environmental assessment

Neither the development of a campsite or caravan site, or associated construction activities, such as the installation of a sewage disposal system, presently require a formal Environmental Assessment (EA). It is unlikely that an individual development proposal would trigger the need for an EA on the basis of significant potential impacts under the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199).

A draft proposal issued by the Commission of the European Union (CEU, 1994) for the amendment of the original EA Directive (CEC, 1985) places camp sites and caravan sites within Annex II of that Directive. This will require that such developments be subject to a formal EA if they are likely to have significant effects on the environment by virtue of their nature, size or location. This proposed amendment is not yet incorporated into UK law.

Regardless of any statutory requirement for EA, the NRA may request environmental information be made available in order to discharge its obligations as competent authority for flood defence, protection of the water environment and consent of discharges to surface waters. An EA may provide the most appropriate method for collating such information. This could follow the guidelines prepared by the Department of the Environment (DoE, 1995) in relation to development projects.

### 4. NRA consents

A discharge consent is required from the NRA under the 1991 Water Resources Act for the discharge of any effluent from a package treatment plant as it may affect the water quality of an area. Under Section 85 of this Act it is a criminal offence for any person to cause or knowingly permit a polluting discharge (including sewage effluent) to enter controlled waters without such consent. The NRA may grant unconditional consent or grant conditional consent subject to certain conditions regarding location, nature and origin of the discharge. Its policy with respect to discharge consents is described in Water Quality Series No. 17 (NRA, 1994a).

A campsite may require NRA consent under local Land Drainage Byelaws, particularly where the erection of any structure in a main river floodplain is likely to divert or obstruct the flow of floodwater. Prospective campsite developers should consult with local NRA Flood Defence staff at an early stage in project planning to discover if such consent will be required.

## 5. Potential impacts

A new campsite development or the extension of an existing site may affect the risk of flood within a floodplain. Sewage disposal may also impact on the water environment. This may take the form of disposal of chemical toilet contents or the discharge to water or land of sewage treatment plant effluent. Impacts may result from the recreational activities of site users and from disposal of domestic waste. Operational impacts of campsites upon the water environment are likely to be most intense in summer months.

### 5.1 Water quality

The presence of micro-organisms would posed a health risk to humans should sewage effluent enter surface waters. This would be a particular cause for concern if the development is situated upstream of an abstraction point for public water supply, or within an area where water-based recreational activities are common.

The high organic content of sewage effluent may cause localised eutrophication with strong growth of algae and "sewage fungus". The high biochemical oxygen demand (BOD) of sewage effluent may cause local de-oxygenation of a watercourse, causing stress for fish and macro-invertebrates. It is probable that such contamination will affect water colour and may result in an offensive odour. An effluent from a package sewage treatment plant may also contain household detergent or other harmful chemicals that could adversely affect surface water quality.

Where sewage effluent is discharge to a soakaway or sub-surface drainage field it may move through the sub-soil and subsequently enter surface waters. Effluent from a well maintained package treatment plant should be of good quality and as such would cause little impact. However, overflow from a cesspool or discharge from a poorly maintained septic tank or package treatment plant may pose a health risk should surface water or groundwater used for public supply become contaminated.

The disposal of chemical toilet waste poses a dual risk for the water environment. If such wastes are discharged directly to surface waters their organic content may result in impacts similar to that of sewage liquor. However, such pollutants will also contain powerful disinfectants and these may have a serious localised impact upon wildlife within a watercourse. Invertebrates and fish are likely to be killed by such chemicals, although the severity of impact will depend upon the dilution capacity of the receiving water. Alternatively, if chemical toilet waste is disposed of to a sewage treatment facility the disinfectants are likely to inhibit or destroy the bacteria that decompose raw sewage. This may cause an increase in the polluting characteristics of sewage effluent discharged.

A campsite is likely to generate a large quantity of other organic waste such as discarded foodstuff. Should rainwater or surface runoff have access to these wastes it may result in organic pollution of surface waters and possibly contamination by trash and packaging material.

### 5.2 Flood defence

Experience has shown that there is an irresistible progression from touring caravan sites through static caravans, to all year habitation, mobile homes and, occasionally, permanent housing. This may have profound implications for the flood defences of an area.

While an individual campsite may have apparently only a very small or negligible effect on flood levels when considered in isolation, a series of such developments may exert a similar impact on flood defence as a single large development whose adverse affects can be more clearly demonstrated. The potential cumulative impacts of progressive floodplain encroachment should therefore be examined in an EA of any individual campsite.

The positioning of any new structures within a floodplain may reduce the capacity of the floodplain to store water and inhibit the downstream and lateral movement of floodwaters. Caravans, ancillary structures, fences and tree planting may all cause obstruction to the passage of flood waters. The fact that caravans may be raised on stilts above flood levels does not mitigate these impacts as the void underneath may be used for storage and eventually may become fully enclosed. This would then present the same obstruction to floodwaters as a permanent building. Such impediments to flood defences may cause risk to property and human life.

### 5.3 Wildlife and amenity

Recreational activities of campsite users may include angling, boating, river bathing and other water-based pastimes. As is usually the case, if large numbers of people use a restricted area of river for recreational purposes, degradation of the water environment may result. River bank erosion may occur with localised sediment deposition that may adversely affect aquatic life. It is possible that such erosion could also damage existing flood defence structures.

Human activity on or near the banks of a river may cause localised destruction or disturbance of riparian vegetation and wildlife. The disposal of litter to surface waters during recreational activities may cause blockage of culverts downstream, injury or disturbance to aquatic wildlife and adverse visual impacts to the water environment.

## 6. Mitigation measures

The main concerns of the NRA in relation to campsite developments are impacts relating to polluting discharges and flood defence. Mitigation of these concerns is assisted where a management plan is drawn up to allow a campsite to operate in harmony with its surroundings. The NRA is able to offer advice on such plans.

### 6.1 Waste disposal

A campsite should be drained to the public foul sewer wherever feasible, although it is recognised that this may not be possible in remote areas. An alternative is to drain a campsite to a sealed tank so that no discharge to controlled waters takes place. However, a large campsite may have a population of several thousand during the peak tourist season and such waste disposal facilities may only be appropriate for smaller campsites.

Where a package sewage treatment system is the only available option, all facilities, including drainage fields, should be constructed and installed to the specifications provided by BS 6297. A percolation test should be conducted to ensure effective operation of a drainage field if one is to be used. The NRA has produced guidelines relating to sewage disposal where no mains drainage is available (NRA, 1992).

The siting of small sewage facilities is important in relation to their potential impact upon water resources. The early evaluation of alternative sites as a means of reducing the impact of a drainage field is a necessary component of an EA. Consultation between developer, planning authorities and the NRA at a preliminary stage in the development process can determine the most appropriate location in a particular situation.

Effective maintenance of a package treatment system is vital to prevent water pollution. The only existing control is that vested in environmental health officers to serve notice on owners of problem installations. There is no control over routine maintenance. Developers should appreciate the importance of regular maintenance of a sewage treatment system and of the possible legal consequences if water pollution is caused by failure to ensure this takes place.

Adequate facilities should be provided to ensure that household wastes are placed in secure structures with no access for rainwater. Litter bins should be positioned in river areas used for recreation.

### 6.2 Flood defence

NRA policy with respect to caravan sites in flood risk areas is stated in *Caravan Sites in Flood Risk Areas* (NRA, 1994b). The NRA believes that any campsite development should meet the following criteria:

- Any new development should not itself flood.
- Development should not increase existing, or cause any new flooding problems on land or to property.
- Development should allow adequate access for future maintenance or improvement of a river channel.
- Development should not cause detriment to the existing flow regime of a watercourse and its environment.

It is NRA policy that:

- Caravans should not be positioned within flood risk areas.
- Caravans should not be isolated from dry land in the event of a flood.
- Existing sites within flood risk areas should not be extended.
- Ancillary buildings should not be positioned on the floodplain.
- Provision must be made to reduce the risk to public safety on existing sites.

In order to avoid potential cumulative impacts of campsites on flood defence, an EA of a proposed campsite development should examine the possible use of alternative sites. The design of a camping ground and positioning of caravans and other structures within a given site may also be used to avoid or reduce possible impacts on flood defence.

## 7. Baseline surveys

Information concerning existing water chemistry, river ecology and flood risk would be required for baseline data in an EA of any campsite. In circumstances where angling or commercial fisheries are important local considerations, a fish survey could be undertaken to collect data although information may be available as local catch records. Where adjacent aquatic and/or riparian environments have a high conservation value a river corridor survey should be carried out.

## 8. Monitoring

An appropriate monitoring strategy should be designed and implemented to confirm the predicted impacts of any campsite development. This should include sampling of any effluent discharged to surface waters and monitoring of the adequacy, performance and maintenance of any sewage treatment facility. Where discharges are greater then $10m^3$ per day the NRA would normally sample this at one monthly intervals in order to assess compliance with a discharge consent. Visits by NRA personnel to campsites situated adjacent to a watercourse may also assist identification of adverse visual impacts, bank erosion and damage to flood defence structures. It may be appropriate for a developer or campsite operator to liaise with the NRA with respect to impact monitoring, particularly in areas where surface water quality or flood defence are matters of some concern.

## 9. References and guidance

British Standards Institution (1983) BS 6297, *Code of Practice for Design and Installation of Small Sewage Treatment Works and Cesspools.*

Commission of the European Communities (1985) On the Assessment of the Effects of Certain Public and Private Projects on the Environment. *Official Journal*, L175, 28th May, Brussels.

Commission of the European Union (1994) Proposal for a Council Directive amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. *Official Journal*, COM 130(07) 12th May, Brussels.

Department of the Environment (1991) *Drainage and Waste Disposal, the Building Regulations.* Approved Document H, HMSO, London.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide.* HMSO, London.

National Rivers Authority (1994a) *Discharge Consents and Compliance: The NRA's Approach to Control of Discharges to Water.* Water Quality Series No. 17, HMSO, London.

National Rivers Authority (1994b) *Caravan Sites in Flood Risk Areas.* Flood Defence Information Sheet No. 14, NRA, Severn-Trent Region.

Payne, J.A. and Butler, D. (1993) *Septic Tanks and Small Sewage Treatment Works: a Guide to Current Practice and Common Problems*. Construction Industry Research and Information Association, Technical Note 146.

**Pollution Prevention Guidelines**

- Pollution Prevention Guidelines 1: *General Guide to the Prevention of Pollution of Controlled Waters*. NRA, Bristol.

- Pollution Prevention Guidelines 4: *Disposal of Sewage Where no Mains Drainage is Available*. NRA, Bristol.

- Pollution Prevention Guidelines 5: *Works in, Near or Liable to Affect Watercourses*. NRA, Bristol.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF SEPTIC TANKS/CESSPOOLS etc.

## 1. Introduction

This guidance note seeks to identify the potential impacts upon the water environment of septic tanks, cesspools and similar sewage storage or disposal facilities. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) for environmental impact studies of proposed developments involving such constructions. The main application for septic tanks and cesspools in the UK is the storage and disposal of sewage from individual properties or premises not connected to a public sewer system. Approximately 4% of dwellings fall into this category.

Septic tanks are designed to act as a settlement container for sewage wastes where anaerobic conditions encourage partial decomposition of organic material. Sewage sludge accumulates within the tank and should be removed periodically. The supernatant from this process is discharged to a drainage field that usually comprises a sub-surface soakaway or irrigation system which allows percolation into the surrounding subsoil. If a septic tank is properly maintained the effluent quality is comparable to that from primary sedimentation tanks at sewage treatment works. Design and construction criteria for both septic tanks and their drainage fields are provided by BS 6297 *Code of Practice for Design and Installation of Small Sewage Treatment Works and Cesspools.*

A cesspool comprises a watertight underground chamber intended only for the storage of raw sewage. No treatment is involved and no discharge to the surrounding environment is intended. In practice cesspools may not be watertight and in such cases act much like a septic tank, where the effluent may or may not be discharged to a drainage field.

## 2. Development control

Most new development involving the construction or installation of septic tanks or cesspools is likely to fall under the Town and Country Planning Act 1990 for the purpose of development control. In addition, planning officers are empowered under the Building Regulations 1991 to ensure such development meets certain criteria regarding the capacity, impermeability, ventilation, siting and construction of a septic tank. They have no control over the design, siting or construction of drainage fields.

The NRA is not a statutory consultee for single dwellings served by private sewage facilities. Nevertheless, a proposed discharge of effluent or leachate which may pollute surface or ground water supplies is a material planning consideration and in such cases the NRA should be consulted at the planning application stage.

## 3. Environmental Assessment

Neither the construction or installation of septic tanks or cesspools, or the construction of single dwellings likely to use such facilities, require a formal Environmental Assessment (EA) under the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199).

The NRA, as competent authority that determines consent to discharge effluent to the water environment, may request environmental information concerning any discharge. Such information may be necessary to enable the NRA to meet its statutory obligations with respect to the protection of the water environment, particularly in regard to the control of pollution of surface waters. Where a development proposal associated with sewage storage or disposal is likely to require NRA consent, an EA may provide the most appropriate means for a developer to collate relevant environmental information. This could follow the guidelines prepared by the Department of the Environment (DoE, 1995) in relation to development projects.

## 4. NRA consents

The NRA is responsible under the 1991 Water Resources Act (WRA) for the control of discharges from septic tanks as they affect the water resources of a region. Under section 85 of this legislation it is a criminal offence to cause or knowingly permit a polluting discharge (such as septic tank effluent) to enter controlled waters unless a consent from the NRA is in force. This includes discharge onto or into the land. The consent procedure is described in *Discharge Consents and Compliance* (NRA, 1994). No consent from the NRA is required for the construction or operation of a cesspool.

The NRA has a duty under the WRA to protect the quality of ground water and conserve its use as a natural resource. Its national policy in this respect is set out in *NRA Policy and Practice for the Protection of Groundwater* (NRA, 1992a). This document, and associated maps, provide a national classification of groundwater vulnerability and definition of protection zones for potable water supply. Septic tank discharges within a Source Protection Zone I designated area are considered unacceptable and the NRA may object in principle to their installation and seek to prohibit discharge. The NRA may also seek to control the use of cesspools within Zone I as effluent leakage from these structures is common. In Zone II the NRA may normally wish to prohibit the use of septic tanks, and in Zone III no objection in principle will be raised provided an appropriate consent is obtained. It should be noted that some regional variation may exist in the type of consents issued.

It is the policy of the NRA to seek to control all sewage effluent discharges to soakaway that are greater than $5m^3$/day. Those of lower flow are controlled only within areas where ground water is judged to be at risk. A consent for septic tank discharge may contain conditions referring to BS 6297 and include clauses preventing discharge close to watercourses.

## 5. Potential impacts

The impacts upon water resources arising from the installation of septic tanks or cesspools are likely to vary with local conditions of geology, soils, geomorphology and hydrology. An EA should therefore ascertain the relevant characteristics of any development site. Any assessment should take into consideration the possibility that an individual septic tank discharge may contribute to a localised cumulative impact upon surface or groundwater caused by organic effluents or leachates from other dwellings, agricultural premises, silage stores and suchlike.

### 5.1 Construction

Impacts upon water resources during the installation of septic tanks or cesspools are likely to be minor and would occur only where the development site is close to a watercourse. Vehicular access to a site may disturb or destroy wildlife habitat and cause some local disruption in surface water flow. Excavation and subsequent disposal of soil for installation of an underground tank may result in washing of loose material into any nearby watercourse, possibly causing a short-term increase in turbidity.

### 5.2 Operation

With careful design, installation and maintenance neither septic tank systems nor cesspools should cause any significant impact upon water resources. Where adverse impacts occur they are likely to be caused by leakage, poor siting of a septic tank drainage field or poor maintenance.

#### 5.2.1 Surface water quality

Sewage effluent may directly contaminate a watercourse from a leaking cesspool or poorly maintained septic tank system, where the tank is full of sludge or the drainage field is inadequate or blocked. As such effluent is strong and often in septic condition the impact upon local surface water quality may be considerable.

The presence of micro-organisms would pose a health risk to humans should sewage effluent enter surface waters. The high organic content of the pollutant might cause localised eutrophication with strong growth of algae and "sewage fungus". The high biochemical oxygen demand (BOD) of sewage liquor might cause local de-oxygenation of a watercourse. It is probable that such contamination would be detrimental to water colour and result in an offensive odour. An effluent might also contain household detergent or other harmful chemicals that would adversely affect water quality.

The risk and intensity of surface water contamination might vary with the proximity of a sewage facility to a watercourse, the steepness of ground slope between them and the type of soil and bedrock. These factors and existing surface water quality adjacent to any new development are important considerations in the assessment of potential impacts.

### 5.2.2 Groundwater quality

Pollution of groundwater may occur from a leaking cesspool or defective septic tank system. The introduction of enteric micro-organisms into groundwater may cause a health hazard where these resources are used to supply human or agricultural needs. The high organic content of sewage liquor and possible presence of chemical agents will also be detrimental to groundwater quality. The organic content of such liquid may contribute to nitrate contamination of groundwater and the cumulative impact of organic wastes and fertilisers on the nitrate concentation of groundwater within a catchment area should be addressed in an EA.

### 5.2.3 Recreation

Where raw sewage liquor enters a watercourse, or lies upon the ground surface in close proximity to it, the amenity and recreation value of such waters will be diminished. Offensive odour will often be present, visual amenity may decrease and the opportunity for activities such as fishing or boating will be restricted.

### 5.2.4 Wildlife

Any discharge from a septic tank or pollution by cesspool effluent would disturb the aquatic community of a watercourse. This would be caused primarily by localised depletion of dissolved oxygen and introduction of a high concentration of nutrients. Strong growth of algae, a reduction of invertebrate diversity and restriction or absence of fish populations could be expected. Although an individual installation might exert only a localised impact on aquatic wildlife, the cumulative effect of all organic discharges within a catchment might lead to a significant change of aquatic flora and fauna along a considerable proportion of a watercourse.

## 6. Mitigation measures

The likelihood of septic tanks or cesspools causing adverse impacts on water resources can be reduced if attention is given at the planning stage to the most appropriate sewage facility required in a particular area, its design and construction, and its location.

The NRA is able to advise a developer or planning authority whether a septic tank or cesspool is best suited to a particular locality. All facilities, including drainage fields, should be constructed and installed to the specifications provided by BS 6297. A percolation test should be conducted to ensure effective operation of a drainage field. The NRA has produced guidelines relating to sewage disposal where no mains drainage is available (NRA, 1992b) that describe how to calculate the required capacity of a septic tank and conduct a percolation test.

The siting of small sewage facilities is important in relation to their potential impact upon water resources. The early evaluation of alternative sites as a means of reducing the impact of septic tanks or drainage fields is a necessary component of an EA. Consultation between developer, planning authority and the NRA at a preliminary stage in the development process can determine the most appropriate location in a particular situation and such consultation is strongly recommended.

Effective maintenance of septic tanks and cesspools is vital to prevent water pollution. The only existing control is the reactive powers vested in environmental health officers to serve notice on owners of problem installations. There is no control over routine maintenance. Developers should be aware of the importance of regular maintenance of septic tanks and of the possible legal consequences if water pollution is caused by failure to ensure this takes place.

## 7. Baseline surveys

In areas deemed vulnerable to pollution a biological survey and chemical analysis may be used to determine the existing quality of surface waters. Where a development is adjacent to a watercourse with a high recreation or conservation value, a river corridor survey may be required. The assessment of baseline conditions within local groundwater will rely on the expertise of NRA personnel, who are available to provide advice to developers on this subject.

## 8. Monitoring

In localities where water resources are particularly vulnerable to pollutants it is prudent to monitor the operation of new sewage facilities over the first year or two of operation. Site inspection will detect obvious leakage from septic tanks or cesspools and this should be undertaken regularly. At sites in close proximity to a watercourse, occasional tests for organic pollution of water should be made over this period in order to detect sub-surface movement of contaminants.

## 9. References and guidance

British Standards Institution (1983) BS 6297, *Code of Practice for Design and Installation of Small Sewage Treatment Works and Cesspools.*

Department of the Environment (1991) *Drainage and Waste Disposal, the Building Regulations.* Approved Document H, HMSO, London.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

National Rivers Authority (1992a) *Policy and Practice for the Protection of Groundwater.* HMSO, London.

National Rivers Authority (1992b) *Disposal of Sewage Where no Mains Drainage is Available.* Pollution Prevention Guidelines No. 4, NRA, Bristol.

National Rivers Authority (1994) *Discharge Consents and Compliance: The NRA's Approach to Control of Discharges to Water.* Water Quality Series No. 17, HMSO, London.

Payne, J.A. and Butler, D. (1993) *Septic Tanks and Small Sewage Treatment Works: a Guide to Current Practice and Common Problems*. Construction Industry Research and Information Association, Technical Note 146.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF VEHICLE PARKS AND PLANT HIRE

## 1. Introduction

This guidance note seeks to identify the potential impacts of vehicle parks and mechanical plant hire premises upon the water environment. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impacts studies of such developments. The NRA has an interest in vehicle parks and plant hire premises due to its environmental responsibilities under the 1991 Water Resources Act, particularly in regard to the control of pollution of controlled waters.

The main activities associated with vehicle parks and mechanical plant hire premises are those of:

- parking and storage of plant/vehicles;
- servicing and repair of plant/vehicles;
- refuelling of plant/vehicles;
- washing and cleaning of plant/vehicles;
- storage of chemicals and petroleum compounds;
- storage and disposal of liquids such as oil, solvents, antifreeze, brake fluid and paint;
- storage and disposal of vehicle tyres, oil filters and batteries.

## 2. Development control

A development proposal for either a vehicle park or mechanical plant hire premises falls under the Town and Country Planning system and will therefore require development consent from a local planning authority.

## 3. Environmental Assessment

There is presently no specific requirement for Environmental Assessment (EA) of vehicle parks or plant hire premises under the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199). A formal EA may nevertheless be required if such facilities form part of a larger development proposal identified in the Regulations which may have a significant effect upon the environment by virtue of its nature, size or location. It is for the local planning authority to determine whether an EA is necessary. It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement follow the guidelines prepared by the Department of the Environment (DoE, 1995).

Whether or not a development proposal for a vehicle park/plant hire premises requires a formal EA, the NRA may request environmental information in order to discharge its obligations as competent authority for flood defence, protection of the water environment and of discharges to controlled waters. An EA may provide the most appropriate method for collating such information.

## 4. NRA consents

Formal consent is required from the NRA under the Water Resources Act 1991 if a proposed development is to discharge trade effluent to either surface or groundwaters (NRA, 1994a). Surface water runoff from industrial or commercial premises is considered to be trade effluent. Developers should be aware that it is a criminal offence under Section 85 of the 1991 Act to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste to enter controlled waters. Fuel oil and other petroleum compounds fall into this category.

## 5. Major potential impacts

The potential impacts of construction activities associated with vehicle parks/plant hire are not dealt with in detail here. The major impact of construction is likely to relate to silt pollution of surface waters. Such pollution, due to large-scale disturbance of topsoil, may increase surface water turbidity with consequent adverse effects upon aquatic fauna and flora. It may also result in excessive deposition of silt within a watercourse. Guidance for EA of construction activities is given in Guidance Note 1 of this series (General Construction).

The operation of vehicle parks or plant hire premises is likely to impact upon the hydrology, morphology and quality of surface waters, and on groundwater quality. These may result in secondary impacts on surface water ecology.

### 5.1 Hydrology/Morphology

The creation of a large impervious area of land surface for vehicular parking or storage may result in significant alteration to existing surface water runoff. If rainwater is allowed to flow directly to a watercourse, land surface erosion may occur. Such runoff may also cause localised erosion of a stream bed or bank where it enters a watercourse.

Erosion caused by surface runoff from a parking area may alter the geomorphological profile of a watercourse. The pattern of sediment distribution within a channel may be changed, with siltation of some areas and scouring of others, thus causing disturbance of bed forms (pools/riffles). Areas of river bank may be weakened or collapse entirely as a result of excessive surface runoff.

An increase in the intensity of local flooding is possible in periods of high rainfall due to the rapid runoff of surface water from covered areas. This may cause additional stream bed and bank erosion that may be detrimental to any existing flood defence works.

If surface water runoff contains dissolved or particulate metals or hydrocarbons, as is common for vehicle service and parking areas (Pitt *et al*, 1995), contaminated sediments may be deposited within a watercourse.

## 5.2 Water quality

Rainwater runoff from a vehicle park or plant hire facility is likely to be contaminated with suspended solids, metals, hydrocarbons and oxygen-depleting substances due to chronic leakage of fuel, lubricants and solvents. Chlorides, sulphates, nitrates and detergents may also be present. The "first flush" of surface drainage from an area used for vehicle storage or maintenance may be highly polluting. Also, as vehicle maintenance or refuelling facilities are likely to store moderate quantities of oil, fuel and solvents, poor storage, handling or disposal, may result in acute pollution of a watercourse. Vandalism within a development site may also cause acute contamination of controlled waters.

Some compounds, such as hydrocarbons and heavy metals, may be directly toxic to aquatic flora and fauna and pose a risk to human heath. Others, such as cleaning agents with a high or low pH may alter the acidity of a watercourse. Compounds with a high biochemical oxygen demand (BOD) could cause localised oxygen depletion and potential eutrophication of surface water.

It is possible that poor storage of chemicals over a period of time may result in pollution of groundwater if leaking material is able to percolate downwards. Contaminants from vehicle parks or plant hire premises may render either surface or groundwater unfit for abstraction to public supply if mandatory EC drinking water standards, as specified by the Drinking Water Directive (EEC/80/778), are exceeded. This Directive lays down 62 parameters relating to the quality of all water provided for human consumption and is implemented by the Water Supply (Water Quality) Regulations 1989 (SI 1989 N$^{o}$ 1147). Pollutants identified by the Directive may cause a direct risk to human health as well as affecting aquatic life. Where a substance is not toxic it may nevertheless alter surface water quality and possibly change the colour, taste or smell of drinking water.

Increased erosion associated with rainwater runoff from large covered areas may cause increased water turbidity and sediment load.

## 5.3 Aquatic ecology

Some pollutants entering a watercourse from an area used for vehicle parking, maintenance, refuelling or cleaning may be toxic to all aquatic life. Most fuels, lubricants and solvents fall into this category and these may cause extensive invertebrate and fish kill. Even low levels of pollutants such as hydrocarbons and solvents may cause loss of sensitive species within a watercourse. Other contaminants, such as suspended solids, may act to inhibit stream flora and so disturb existing aquatic communities. Compounds that possess a high BOD may cause localised invertebrate and fish kill due to oxygen depletion.

Chemical parameters designated as necessary for the protection or improvement of fresh waters in order to support fish life (NRA, 1994b) may be exceeded by pollutants from vehicle parks or plant hire premises. Mandatory parameters include pH, non-ionised ammonia, total ammonium, total residual chorine and total zinc. The dilution potential of a watercourse can be critical in ameliorating the impact of catastrophic chemical release. An increased intensity of flooding after rainfall may destabilise the aquatic community. Erosion and/or siltation resulting from rapid surface runoff may cause change to the species composition of a stream bed habitat. Erosion is likely to inhibit the presence of benthic algae and invertebrates, while siltation may allow only those animals adapted to living in mud and silt to remain.

Increased turbidity associated with land, bank or bed erosion may directly injure fish by abrasion to the gills. Such turbidity may also alter fish behaviour. Deposition of material within a watercourse may disturb fish spawning gravels and thereby reduce the fisheries value of a stream.

## 6. Mitigation measures

The intention of measures to reduce or avoid impacts upon the water environment from vehicle parks or plant hire premises is to ensure the erosive force of surface runoff and all potential pollutants are contained. To this end it is preferable that:

- Where rainwater runoff is drained to a watercourse the drainage system should be designed to release water slowly after heavy storms. Outlets into surface waters should be located sensitively to minimise erosion of stream bed and banks and to reduce the velocity of discharge.
- All vehicle service areas should have a suitably sized oil separator (interceptor) installed on the surface water drainage system. This should be regularly inspected and cleaned as required. A pollution prevention guidance note on oil separators is available from the NRA (see references).
- Vehicle parks and yards should drain to an oil separator if pollutants are likely to exist in the runoff. Where vehicle parks or yards become muddy with use, all surfaces should be swept at regular intervals and drainage directed to a solids settlement tank/lagoon before entering the oil separator.
- Clean roof water should discharge directly to the surface water system downstream of any oil separator.
- High risk areas, trade effluent and offices should drain either to the public foul drainage system or to a sealed containment facility. Developers should contact the water utilities Trade Effluent Control staff concerning the acceptability of discharging such drainage to the foul sewer.
- Vehicle wash water should be recycled where possible, or alternatively, discharged to the public foul drainage system. Pollution Prevention Guidance Note 13 deals with water and steam cleaners (see references).
- Above ground oil storage tanks and drums should be sited on an impervious base within an oil-tight bund. There should be no drainage outlet. Guidance notes on the storage and disposal of oil and fuel are available from the NRA (see references).
- Refuelling areas should be isolated from the general drainage system. A guidance note on fuelling areas is available from the NRA (see references).
- Used liquids such as hydraulic fluid, coolant and solvents must not be disposed of to surface waters. They should be collected in sealed containers for disposal by a licensed contractor. All containers must be stored in a bunded area and the location where drums/containers are filled must be adequately protected against chemical spillage.
- Design and operational criteria regarding storage facilities for all wastes should be included in the design stage of any development. This should include facilities for fluids, oil filters, batteries, tyres and any other wastes.
- Sites incorporating vehicle parks or plant hire facilities should be designed to minimise

the risk of vandalism (CIRIA, 1994). Staff should be trained to make appropriate responses, and procedures to deal with any threat to the water environment arising from vandalism or accidential spillages should be formulated.

Consideration should also be given to local solutions for treating rapid runoff from any site. This may include the provision of grass swales, wetlands, balancing ponds and permeable pavements. The NRA are able to provide advice on such measures.

## 7. Baseline surveys

Baseline information concerning the flow, chemical water quality and biological status of any adjacent watercourse would be necessary for an EA of a vehicle park or plant hire facility. This would require hydrological, chemical and ecological surveys adjacent and downstream of the development. Predictions of runoff rates from vehicle parking areas under various scenarios of rainfall would also be required.

## 8. Monitoring and audit

A monitoring programme for periodic inspection of all fluid and other waste storage and disposal systems associated with the development should be designed and implemented. It is essential that oil separators and fluid storage facilities are regularly inspected and maintained. A site operational schedule should indicate the timing of inspections for individual facilities. A record should be maintained of inspections that are carried out and maintenance and/or remedial works that have been completed. Water quality of any adjacent watercourse should be assessed at intervals by chemical and biological surveys to confirm the effectiveness of mitigation measures.

## 9. References and guidance

Construction Industry Research and Information Association (1994) *Dealing with Vandalism - A Guide to the Control of Vandalism*. Special Publication 91, CIRIA, London.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide*. HMSO, London.

National Rivers Authority (1994a) *Discharge Consents and Compliance - the NRA's Approach to Control of Discharges to Water*. Water Quality Series No. 17. HMSO, London.

National Rivers Authority (1994b) *Implementation of the EC Freshwater Fish Directive: Water Quality Requirements for the Support of Fish Life*. Water Quality Series No. 20, HMSO, London.

Pitt, R., Field, R., Lalor, M. & Brown, M. (1995) Urban stormwater toxic pollutants: assessment, sources and treatability. *Water Environment Research* 67 (3) 260-275.

## Pollution Prevention Guidelines

- Pollution Prevention Guidelines 1: *General Guide to the Prevention of Pollution of Controlled Waters*. NRA, Bristol.
- Pollution Prevention Guidelines 2: *Above Ground Oil Storage Tanks*. NRA, Bristol.
- Pollution Prevention Guidelines 3: *The Use and Design of Oil Separators in Surface Water Drainage Systems*. NRA, Bristol.
- Pollution Prevention Guidelines 7: *Fuelling Stations - Construction & Operation*. NRA, Bristol.
- Pollution Prevention Guidelines 8: *Safe Storage and Disposal of Used Oils*. NRA, Bristol.
- Pollution Prevention Guidelines 13. *High Pressure Water and Steam Cleaners*. NRA, Bristol.
- Pollution Prevention Guidelines 19: *Preventing Pollution from Garages and Vehicle Service Centres*. NRA, Bristol.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF SWIMMING POOLS

Due to the relatively minor issues associated with this topic area, a Further Guidance Note was not considered necessary. Please refer back to "Scoping Guidance for the Environmental Assessment of Projects".

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CHEMICAL STORAGE UNITS

## 1. Introduction

This guidance note seeks to identify the potential impacts of chemical storage units on the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of such developments. The NRA has an interest in chemical storage facilities due to its statutory responsibilities for the protection of water quality, particularly in regard to the control of pollution of groundwater and surface waters.

Many industrial and commercial developments store chemicals that are used as components in manufacturing or other operations. Some developments are concerned with the import, export or manufacture of such chemicals and therefore store them in very large quantities. The range of chemical substances that may be stored on industrial or commercial premises is far too great to describe here but includes compounds such as petrochemicals, acids, alkaloids, pesticides, paints and solvents. Some may be toxic in small quantities, others may be flammable or explosive and so present an obvious danger to the water environment. Others, such as non-toxic and low toxicity organic materials, may not be directly hazardous to humans but nevertheless act as harmful pollutants within surface or groundwaters.

Chemicals were responsible for 7.5% of substantiated water pollution incidents from industrial sources in 1994, but these accounted for 23% of Category 1 incidents (NRA, 1995). Paints and dyes were the most commonly identified chemical pollutants and caused 16% of incidents. Other types of contaminant were detergents (12%), other inorganics (6%), acid (5%), alkali (4%) and pesticides (3%).

Pollution from chemical storage units represents a large scale and ubiquitous hazard for the water environment. All chemical storage facilities have the potential to contaminate surface and groundwaters. Catastrophic incidents following fire, explosion or large scale spillage can cause rapid and extensive damage to surface waters. Indeed, the water used by fire-fighters to control a fire may itself carry contaminating materials to any nearby watercourse and the foam used to extinguish some types of fire is itself a pollutant. An additional potential cause of catastrophic water pollution is vandalism to chemical storage facilities.

Small scale chronic leakage through a permeable (cracked) base of a storage unit often results in the contamination of groundwater. Beneath many chemical storage complexes in England and Wales there is a plume of contaminated groundwater, and pollutants may be found beneath most chemical processing sites.

The NRA is able to provide advice on the risks to the aquatic environment posed by a new development containing chemical storage units. Liaison with local NRA staff at the planning stage of new developments is recommended so that issues of concern may be identified at this time.

## 2. Development control

Developments likely to involve the large scale storage of chemicals will usually fall under the Town and Country Planning system and will therefore require consent from a local planning authority. For storage of certain chemicals the Planning (Hazardous Substances) Act 1990 as implemented by the Regulations (SI 1992 Nº 656) may apply.

The NRA is a statutory consultee of the Hazardous Substances Authority (Local Planning Authority) and for proposed developments that require Environmental Assessment (EA). As such it may recommend refusal of planning permission or an imposition of conditions relating to design and operational criteria.

## 3. Environmental Assessment

Several types of manufacturing/processing developments that may involve bulk storage of chemicals are listed as Schedule 1 projects in the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199) and will therefore require EA in every case. These are:
- A crude oil refinery (with some exclusions) or an installation for the gasification and liquefaction of 500 tonnes or more of coal or bituminous shale per day.
- An integrated chemical installation; that is, an industrial installation or group of installations where two or more linked chemical or physical processes are employed for the manufacture of olefins from petroleum products, or of sulphuric acid, nitric acid, hydrofluoric acid, chlorine or fluorine.
- A waste-disposal installation for the incineration of chemical treatment of special waste.

The European Community Directive on Environmental Assessment (CEC, 1985) is currently being amended. A proposed amendment has been published (CEU, 1994) but has not yet been accepted by member states. This proposal would, if agreed, redefine the category of integrated chemical installations as listed under Annex 1 (Schedule I of UK Regulations) as:
- Installations located in a geographical area in which several units for the industrial production of chemical products, not necessarily belonging to the same company, are juxtaposed and are functionally linked to each other.

Some types of development that will entail storage of chemicals are listed as Schedule 2 projects in the 1988 Regulations and may require EA if they are likely to have significant effects on the environment by virtue of factors such as their nature, size or location. These are:
- The treatment of intermediate products and production of chemicals, other than development falling under Schedule 1.
- The production of pesticides or pharmaceutical products, paints or varnishes, elastomers or peroxides.
- The storage of petroleum or petrochemical or chemical products.

It is for a local planning authority to decide whether an EA of a development type listed as a Schedule 2 project is required to accompany an application for development consent. In all cases, it is the responsibility of a developer to conduct an EA if required and to prepare an Environmental Statement. It is recommended that the conduct of an EA and subsequent preparation of an Environmental Statement follow the guidelines prepared by the Department of the Environment (DoE, 1995).

Whether or not a formal EA of a chemical storage unit is required the NRA, as a statutory consultee to development proposals that may affect the water environment, may request environmental information concerning the proposal. Such information may be needed to enable the NRA to meet its statutory obligations with respect to the protection of the water environment, particularly in regard to the control of pollution of groundwater and surface waters. An EA may provide the most appropriate method of collating the necessary information.

## 4. NRA consents

The NRA is responsible for the protection of the water environment from pollution under the 1991 Water Resources Act (WRA). This Act applies to all controlled waters (rivers, canals, lakes, groundwaters and coastal waters) within England and Wales. All discharges to these waters requires consent from the NRA and may be subject to certain conditions relating to the type, volume and place of discharge. It is an offence under Section 85 of the WRA to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste to enter controlled waters.

### 4.1 Other licences

Certain prescribed processes and substances are subject to Regulations implementing Part 1 of the Environmental Protection Act 1990. Storage, use and disposal of chemicals used in specified industrial operations require an authorisation from Her Majesty's Inspectorate of Pollution (HMIP) under the system of Integrated Pollution Control (IPC). Releases to land, air and water of hazardous substances identified by the Environmental Protection (Prescribed Processes and Substances) (Amendment) Regulations 1992 (SI 1992 Nº 614) are also controlled by HMIP. Where a process does not fall under IPC, consent from the NRA is required, as described in the previous section. In April 1996 the regulatory powers of these two bodies will be combined within the new Environment Agency. With respect to the use, storage and discharge of material to all environmental media, including water, the Agency will be responsible for all authorisation.

Some sites may fall under the Control of Industrial Major Accident Hazard Regulations 1984 (SI 1984 Nº 1902) which are enforced by the Health and Safety Executive. These aim to prevent major industrial accidents and to limit the consequences to people and the environment of any that do occur.

## 5. Major potential impacts

The types of chemicals held in bulk storage facilities are so diverse as to make possible only broad guidelines for EA of their potential impact on the water environment. An EA of any chemical storage facility should determine, for each and every chemical compound to be stored, its potential effect on groundwater and surface water quality and wildlife at a range of concentrations. The effect of liquids from adjacent chemical stores becoming mixed should be assessed, as should the question of any chemical's reaction with water and the end products which may result.

The siting of any chemical storage unit is also an important factor to be considered in an EA. Assessment of the sensitivity of a site based on its nature and location should be undertaken. Factors that should be considered are provided in the NRA's Pollution Prevention Guidelines No. 17.

The impacts of construction activities for chemical storage works on the water environment are not discussed here but information is provided by Guidance Note 1 of this series (General Construction). Other guidance on EA relevant to chemical storage units are:

- Guidance Note 12 (Large Industrial/Manufacturing Development)
- Guidance Note 17 (Oil Refineries/Oil Exploration)
- Guidance Note 55 (Vehicle Parks/Plant Hire)

### 5.1 Groundwater

As previously indicated, chronic leakage from chemical storage units over a period of time may pose a major threat to groundwater quality. Obviously, the nature and intensity of any impact will depend on the chemical composition of any contaminant, the rate of leakage and length of time over which contamination has occurred. The persistence, solubility and volatility of a substance are also important considerations. The degree of impact will also depend to a large extent on the geological and hydrological characteristics of a site and its proximity to any aquifer. A permeable limestone, particularly when fissured, may enable rapid percolation of a contaminant to a considerable depth, whereas impermeable strata may cause lateral migration of polluting material, possibly emerging to surface waters.

At best, contamination of groundwater by leakage from a chemical storage facility may cause only a minor change in water quality. If a contaminant is toxic however and groundwater adjacent to a site is used for potable water or agricultural supply, the resulting impact is likely to be severe. As it is very difficult and expensive to decontaminate a polluted aquifer, even where such an action is possible, that water would no longer be available as a water supply source. In order to protect vulnerable groundwater resources it is the policy of the NRA to object to the siting of any new chemical storage facility within Source Protections Zones I and II and to encourage new developments in areas of low vulnerability to groundwater (NRA, 1992).

### 5.2 Surface water

The surface water environment may be affected by the physical presence of a chemical storage facility and may become polluted by acute or chronic release of material. Potential impacts are discussed here in broad terms only as their nature and intensity will depend on the composition of any polluting material and the physical characteristics of a site. An EA of proposed development should take these factors into account in the assessment of potential impacts on surface waters.

### 5.2.1 Hydrology/morphology

The creation of a large impervious area of land surface for chemical storage units, buildings and vehicular parking may result in significant alteration to existing surface water runoff. If rainwater is allowed to flow directly to a watercourse, land surface or river bank erosion may occur.

Erosion caused by surface runoff may substantially alter the geomorphological profile of a watercourse. The pattern of sediment distribution within a channel may be changed, with siltation of some areas and scouring of others. Areas of river bank may be weakened or collapse entirely as a result of excessive riparian drainage.

An increase in the intensity of local flooding is likely in periods of high rainfall due to the rapid runoff of surface water from covered areas. This may cause additional stream bed and bank erosion that may be detrimental to any existing flood defence works.

If surface water runoff contains harmful dissolved or suspended material from a chemical storage facility, contaminated sediments such as heavy metals may be deposited within a watercourse.

### 5.2.2 Water quality

A catastrophic incident within a chemical storage facility may result in direct discharge of a large quantity of polluting material to surface and/or groundwaters. This may render the water unfit for abstraction to public supply as mandatory EC drinking water standards as specified by the Drinking Water Directive (EEC/80/778) may be exceeded. This Directive lays down 62 parameters relating to the quality of all water provided for human consumption and is implemented by the Water Supply (Water Quality) Regulations 1989 (SI 1989 Nº 1147). Pollutants identified by the Directive may cause a direct risk to human health as well as affecting aquatic life. Where a substance is not toxic it may nevertheless substantially alter surface water quality upon contact. Chemical parameters that are designated as necessary for the protection or improvement of fresh waters in order to support fish life (NRA, 1994) are likely to be broken. Mandatory parameters include pH, non-ionised ammonia, total ammonium, total residual chorine and total zinc. The dilution potential of a watercourse may be critical in ameliorating the impact of catastrophic chemical release.

Where a chemical storage unit or associated activities are responsible for a slow leakage of compounds to surface waters, this may cause change in the chemistry, nutrient status, turbidity, oxygen content or pH of a water body.

### 5.2.3 Wildlife

A catastrophic leakage of stored chemicals may exert a devastating effect on aquatic organisms. Compounds that are directly toxic may cause extensive plant, invertebrate and fish kills downstream of any incident. Where pollutants are not themselves toxic, or leakage occurs on a small scale over a period of time, contamination may nevertheless cause modification to the species composition and diversity within surface waters as a result of change in water quality. Species sensitive to a particular environmental parameter, such as dissolved oxygen or pH, may no longer be able to exist within affected waters. In coastal waters, contamination such as oil may taint mussels and fish within and render them inedible.

Where surface waters are contaminated by a slow input of organic or reducing compounds, this may result in a decrease of invertebrate numbers and diversity, due primarily to de-oxygenation of the water. Where pollution is severe, only a very restricted invertebrate fauna will be present. Excessive algal growth due to nutrient enrichment may occur and "sewage fungus" (an algal/bacterial conglomeration) may be found. Precipitation of reducing compounds in a watercourse may lead to profound change in the benthic community and lead to anaerobic conditions within the bottom sediments.

Spillage of oil, whether chronic or acute, may exert a profound adverse impact on aquatic habitats and species. This may not be confined to aquatic organisms but may extend to birds, amphibians and terrestrial mammals. These may be poisoned by ingestion of oil or suffer injury or death as a result of incapacity resulting from contact with the pollutant.

The introduction of suspended solids to a watercourse can cause direct damage to aquatic life through light attenuation and smothering effect. Where such material is toxic, this may lead to long term degradation of the benthic community.

### 5.2.4 Recreation/amenity

A catastrophic leakage from a chemical storage facility may exert direct adverse impacts on the use of surface water as a recreational and amenity resource. This may result from a threat to human health by toxic compounds or from the presence of offensive odour or smell. In the event of fish kill, the fisheries value of a watercourse may be reduced for several years. An acute leakage from a chemical storage unit may cause a similar reduction in recreation and amenity value of surface waters, although this type of impact may not be immediately apparent.

## 6. Mitigation measures

Mitigation measures to avoid or reduce potential impacts on the water environment from chemical storage units should aim to prevent the release of chemicals and to ensure that any inadvertent release is contained. Guidance has been provided by the NRA on a range of relevant subjects in the form of Pollution Prevention Guidelines (see references) to assist developers.

A primary consideration in impact mitigation must be the siting of a chemical storage facility and it is NRA policy to seek the preferential location of new industrial development in areas which are not vulnerable to groundwater pollution (NRA, 1992). Specifically, the NRA will seek to influence any new proposal for the significant use, storage or manufacture of Lists I and List II chemicals, as defined in the EC Groundwater Directive (80/68/EEC), whether in raw or waste form, so they are preferentially located on Non-Aquifers.

In order to minimise potential impacts on the water environment the design and operation of a chemical storage unit must ensure that:

- All chemical storage areas are located on an impervious base and within a bund that has a capacity of at least 110% of the maximum capacity for chemical storage. NRA staff should be consulted regarding appropriate bunding capacity.
- A full risk assessment is carried out for each and every chemical to be stored and the appropriate containment measures installed. NRA staff should be consulted regarding the containment design of all chemical storage facilities.
- The design and construction of chemical storage facilities is sufficiently robust to prevent or minimise vandalism (CIRIA, 1994).
- Toxic chemicals are stored under cover wherever possible and that they are kept dry and secure from unauthorised access.
- Secondary bunding is installed around the perimeter of a site where necessary. This will be particularly appropriate where a chemical storage unit is in close proximity to any watercourse.
- Secondary containment measures, such as containment lagoons and holding tanks are installed where appropriate.
- An Emergency Plan is formulated and tested through exercises to ensure that procedures to prevent or mitigate impacts due to accidents or spillages are in place and operate effectively.

Detailed advice concerning emergency plans, chemical storage, chemical inventories, delivery and handling of polluting substances, secondary containment systems and emergency materials and equipment are provided in the NRA Pollution Prevention Guidelines No. 18 *Pollution Prevention Measures for the Control of Spillages and Fire Fighting Run-off.*

## 7. Baseline surveys

A minimum requirement for baseline information to be used in EA of a development proposal for chemical storage units would be time-series data concerning water chemistry and biology of any adjacent watercourse. Hydrological information such as minimum and mean flows would also be important as these factors will determine the dilution potential of a watercourse.

Where possible a survey of aquatic and marginal flora and fauna should be undertaken to determine whether sensitive or rare species are present.

## 8. Monitoring

It is essential that on-site safety monitoring of chemical storage, handling and processing operations are an integral part of the day-to-day management of industrial or commercial sites containing chemical storage units. Security arrangements must be regularly reviewed. A comprehensive impact monitoring program should be designed and implemented to ensure that chemical leakage is detected at an early stage if this should occur. Monitoring of the water environment should take the form of regular chemical and biological sampling of any nearby watercourse and periodic sampling of subterranean water beneath a storage complex.

## 9. References and guidance

Commission of the European Communities (1985) On the Assessment of the Effects of Certain Public and Private Projects on the Environment. *Official Journal*, L175, 28th May, Brussels.

Commission of the European Union (1994) Proposal for a Council Directive Amending Directive 85/337/EEC on the Assessment of the Effects of Certain Public and Private Projects on the Environment. *Official Journal*, COM 130(07) 12th May, Brussels.

Construction Industry Research and Information Association (1994) *Dealing with Vandalism - A Guide to the Control of Vandalism*. Special Publication 91, CIRIA, London.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide*. HMSO, London.

National Rivers Authority (1992) *Policy and Practice for the Protection of Groundwater*. HMSO, London.

National Rivers Authority (1994) *Implementation of the EC Freshwater Fish Directive: Water Quality Requirements for the Support of Fish Life*. Water Quality Series No. 20, HMSO, London.

National Rivers Authority (1995) *Water Pollution Incidents in England and Wales: Report of the National Rivers Authority*. Water Quality Series No. 25, HMSO, London.

### Pollution Prevention Guidelines

- Pollution Prevention Guidelines 1: *General Guide to the Prevention of Pollution of Controlled Waters*. NRA, Bristol.
- Pollution Prevention Guidelines 2: *Above Ground Oil Storage Tanks*. NRA, Bristol.
- Pollution Prevention Guidelines 3: *The Use and Design of Oil Separators in Surface Water Drainage Systems*. NRA, Bristol.
- Pollution Prevention Guidelines 8: *Safe Storage and Disposal of Used Oils*. NRA, Bristol.
- Pollution Prevention Guidelines 11. *Preventing Pollution on Industrial Sites*. NRA, Bristol.
- Pollution Prevention Guidelines 18. *Pollution Prevention Measures for the Control of Spillages and Fire Fighting Run-off*. NRA, Bristol.

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF PETROL STATIONS

See Guidance Note 57.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF PEAT EXTRACTION

## 1. Introduction

This guidance note seeks to identify the potential impacts of peat extraction upon the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of peat extraction schemes. The NRA has an interest in such projects due to its environmental responsibilities under the Water Resources Act 1991, particularly with respect to those concerning water quality, water resources and conservation.

Peatlands are formed by the accumulation of partially decomposed plant material under waterlogged, anaerobic conditions. They can be divided into two types: ombrotrophic peatlands, fed exclusively by precipitation and minerotrophic peatlands which are additionally fed by groundwater and/or streams.

Ombrotrophic peatlands are found as blanket bogs, typically on elevated ground with high precipitation, cool temperatures and poor drainage, and as lowland raised bogs on low plains or valley floors where the growth and capillary action of bog moss (*Sphagnum* spp.) creates a domed structure where the bog surface is raised above the water table.

Minerotrophic peatlands are often described as fens. Topogenous fens are those where water movements in the peat are generally vertical and include basin fens and floodplain fens. Soligenous fens are those where water movement is predominantly lateral and include mires associated with lowland or upland springs. As the name implies, minerotrophic peatlands receive dissolved minerals from ground or surface waters. This may be from base-poor rock, such as upland sandstone or granite, and these 'poor' fens contain acid water (pH of 5 or less) and few plant or animal species. Rich fens, fed by mineral-rich calcareous waters (pH 5 or more) are mainly confined to the lowlands.

The physical structure of a peat deposit comprises the catotelm, a layer of amorphous, partially decomposed plant material that lies above a mineral substratum. It is constantly saturated with water and hence anaerobic. This layer may be many metres thick, representing accumulation over thousands of years. Above the catotelm lies the acrotelm, which comprises mainly fibrous plant material, not yet decomposed, and surface vegetation. This layer has a variable water content, depending on the water table, and is aerobic.

Peatlands have a high conservation value for wildlife and archaeological heritage. Raised bogs are listed in Annex 1 of the EC Habitats Directive and many in the UK have been notified as Sites of Special Scientific Interest. Fen and bog habitats support a diversity of plant and animal communities and some contain up to one third of the UK native plant species, up to half the UK's species of dragonfly and several thousand other insect species. The mossy hummocks and pools of bogs provide vital nesting and feeding grounds for wading birds, and many wildfowl and birds of prey overwinter in peatland habitats (RSPB, 1993).

Peat is extracted primarily for use as growing media or soil improver in horticulture, although it is also used to a limited extent as a fuel, in forestry, whiskey production and animal breeding. In the UK, $3 \times 10^6$ $m^3$ are mined each year, half of which is from lowland raised bogs.

Commercial peat extraction may take several forms although common to all is the need to first drain a site and divert surface waters where necessary to allow desiccation of the peat. Peatland drainage ditches are commonly 1 metre deep, set at 15-20 metres spacing. These connect to peripheral drains, perhaps 2 metres deep which in turn connect to the surface water drainage system. It may take three years or more for an area of peatland to become sufficiently dry to support heavy machinery (WRc, 1993). Extraction of peat may then be undertaken by trench cutting machines that cut peat in sections and leave small sods or blocks on the surface to dry further. Alternatively, the peatland surface may be cleared of vegetation and rotavation or milling machines used to scarify the exposed peat. This is allowed to dry *in situ* before removal.

The Government's policy for peatlands is set out in Mineral Planning Guidance 13: *Guidelines for Peat Provision In England including the Place of Alternative Materials* (DoE, 1995a). In brief this is to:

- conserve a sufficient range, distribution and number of all peatland habitats;
- avoid where practicable destruction of important archaeological remains in peatland;
- enable the horticultural industry to continue to be supplied with peat - and also to encourage the development and use of suitable alternatives;
- provide a suitable framework for updating old permissions for peat extraction, especially in respect of rehabilitation of sites.

## 2. Development control

Control over the extraction of minerals, including peat, lies with local mineral planning authorities (MPA). Policies are set out in a local minerals plan and planning applications determined in accordance with the relevant plan unless material considerations indicate otherwise. The NRA is a statutory consultee for mineral extraction applications. A MPA may specify planning conditions in granting development consent.

Minerals development differs from other forms of development because minerals can only be worked where they are found and working can last for many years. Environmental standards change and the original planning conditions can become outdated. The Planning and Compensation Act 1991 introduced measures to deal with Interim Development Order permissions, granted between 1943 and 1948, under which the peat industry had to submit new conditions for the approval of the MPA. New provisions introduced by section 96 and Schedules 13 and 14 of the Environment Act 1995 provide for an initial review and updating of permissions granted in the 1950s, 60s and 70s, and the periodic review of all mineral permissions thereafter. New conditions may be placed on these existing permissions.

Government guidance for local authorities and the minerals industry on the extraction of peat states that any future peat extraction from new sites should be restricted to areas which have already been damaged by recent human activities and are of limited or no nature conservation value (DoE, 1995a).

### 3. Environmental Assessment

The extraction of peat is listed in Schedule 2 of the Town and Country Planning (Assessment of Environmental Effects) Regulations (SI 1988 Nº 1199). Any such developments may therefore require Environmental Assessment (EA) if they are likely to have a significant effect on the environment by virtue of their nature, size or location. It is for the MPA to determine whether an EA should be undertaken. The conduct of an EA and subsequent preparation of an Environmental Statement should follow the guidelines prepared by the Department of the Environment (DoE, 1995b).

Whether or not a formal EA of a proposed peat extraction scheme is required by a MPA, it may be desirable to undertake some form of assessment. The NRA, as the competent authority that determines consent to discharge effluent to the water environment, may request environmental information concerning a proposal that involves such a discharge. This information may be necessary to enable the NRA to meet its statutory obligations with respect to the protection of the water environment, particularly in regard to the control of pollution of surface waters. Where a development proposal associated with peat extraction is likely to require NRA discharge consent, an EA may provide the most appropriate method for a developer to collate relevant environmental information.

### 4. NRA consents/licences

Discharges from any mineral working, including peat extraction, are subject to statutory control under the Water Resources Act 1991 and need prior consent from the NRA. In some situations, abstraction of water from drainage ditches within a peat extraction site may require a licence from the NRA. Diversion of surface waters around any form of peatland will require Land Drainage Consent under either the Water Resources Act or the Land Drainage Act 1991.

### 5. Major potential impacts

Potential impacts on the water environment arising from the extraction of peat are likely to occur in both the site preparation phase and peat extraction phase of any development. These are described below under headings of separate environmental components.

#### 5.1 Groundwater

Drainage of peatland will reduce the level of a water table. This in turn may reduce groundwater recharge and diminish local groundwater storage capacity. Whereas an intact peat body will have a relatively stable internal water level, at least in the catotelm, after drainage ditches are cut the water level is likely to fluctuate. Changes in water level of as little as 1-5cm can have a significant influence on plant communities (Smart, 1991).

## 5.2 Surface water hydrology/morphology

Diversion of a natural surface water drainage system around soligenous fens and the excavation of drainage ditches in any peatland will substantially alter surface water runoff. This may cause an increased volume of water to discharge from a catchment, either as baseflow or stormflow (WRc, 1993).

Where peatland is stripped of vegetation and drainage discharged into surface waters, existing flow volume and velocities in river channels may be increased. The magnitude and duration of flood events, particularly in lowland areas, are likely to be changed.

The excavation of drainage channels and peat are likely to cause suspension of organic sediments in drainage water, with subsequent downstream deposition over a long period of time. This may result in change of natural channel morphology and loss of morphological variability due to extensive sediment deposition. Changes in bed level may cause channel adjustment up and downstream, loss of pool-riffle sequence and bank instability.

## 5.3 Surface water quality

Excavation of drainage ditches and peat working are likely to increase the suspended solid load of receiving surface waters. This is often considered to be the most significant impact of peat extraction on surface water quality (WRc, 1993). The solids would most probably consist of fine amorphous organic material from the catotelm that would also significantly increase the biochemical oxygen demand (BOD) of surface drainage waters. The severity of impact caused by drainage waters from a peat extraction scheme would depend upon the degree of dilution that has occurred within the receiving surface waters.

Newly cut peat in drainage channels is exposed to air and higher temperatures than previously. In such conditions, organic nitrogen within the peat is oxidised to ammonium and then to nitrate by the action of bacteria. This, together with phosphates also leached from newly cut peat, is likely to significantly increase the concentration of these nutrients in receiving surface waters.

Oxidation of newly-exposed peat may produce sulphuric acid (Smart, 1991) which, in conjunction with the carbonic and organic acids present in all peatlands, may significantly increase the pH of surface waters receiving drainage from a peat extraction scheme. The intensity of this impact will depend on the alkalinity of the receiving waters and its proximity to the peat. Where the surrounding geology provides a neutral or alkaline surface water that is in intimate contact with the peat, as in many fens, the impact of acidic peatland drainage will be reduced. Drainage channels may act as acidic buffers for peatland run-off, particularly if they extend down into the basal rock.

The colour of waters receiving drainage from a peat extraction scheme is likely to be changed by organic and humic compounds present in the drainage effluent.

The use of machinery and storage of fuel and oil on peatlands during site preparation and peat extraction may lead to surface water pollution through spillage, leakage or accident.

The materials used in the creation of access roads, such as chalk/limestone rubble or slag, may exert an impact on the pH of local water.

## 5.4 Aquatic ecology

**Wetlands**
Extraction of peat may destroy or disturb large areas of wetland habitat. Cutting of drainage ditches will obviously cause physical destruction of some wetland habitat in bogs and fens. In addition, lowering of a water table and associated desiccation of peat may result in considerable changes to wetland habitat within and adjacent to any peat extraction site. This may significantly alter existing habitats for a considerable distance from any peat cut. For example, hummocks and hollows found in bog moss provide a variety of micro-habitats colonised by a very specific flora and fauna; these physical features are lost when a bog is drained (DoE, 1995a).

Peat drainage and subsequent desiccation may displace sensitive fauna that inhabit the natural peatland habitat. Dragonflies, for example, are declining in numbers and variety within the UK (British Dragonfly Society, 1991). Peat bogs represent the main breeding habitat for one third of the resident species as they are able to tolerate acidic conditions. The drying of peatlands and peat extraction, particularly by milling, destroys dragonfly breeding sites.

Marginal wetland habitats may also undergo change due to drainage of a bog or fen. Drying of the peat surface or removal of peat from bog margins encourages the spread of self-sown scrub, in particular birch.

**Surface waters**
The ecology of surface waters receiving drainage from a peat extraction scheme may be disturbed by the high suspended solid load, high nutrient content, high BOD and low pH of drainage waters.

Suspended sediments may cause direct damage to fish gills and cause suffocation. These may also reduce light penetration in water and coat vegetation, thereby reducing photosynthesis and plant growth.

Deposition of sediments may disturb or destroy existing benthic and emergent habitats within receiving waters. Benthic flora and fauna may be displaced by the smothering action of sediments downstream of peat drainage channels. Interstitial spaces between stones and gravel particles that provide shelter for many invertebrates are likely to be filled. Fish spawning may be interrupted and fish eggs or juveniles found in river gravels may be damaged by material deposition. In the longer term, change in the substrata of a river bed may result in a reduction of ecological diversity and loss of fish spawning gravels and/or plant cover. Marginal aquatic habitats downstream of a peat extraction scheme may also be smothered by the deposition of sediments.
The input of nutrients from peatlands to surface waters may result in excessive algal growth, or eutrophication. Phosphate is most often the limiting nutrient for algal growth in freshwaters and the addition of this nutrient may cause explosive growth of algae. Algal blooms have a detrimental visual impact and may have serious cost implications where surface water is used for public supply as they may block sand filters used in the

purification of drinking water. Eutrophication of surface waters may cause invertebrate and fish kill by destabilising the normal oxygen balance of waters or through the production of toxins by blue-green algae.

The high BOD of peat drainage water is likely to cause depletion of dissolved oxygen in surface receiving waters. A continuous discharge of this kind may result in the disappearance of sensitive species and a significant change in the composition of an aquatic community. In some situations, where organic sediments with a high BOD are deposited within a stream, the water may contain very little oxygen and the sediments can produce methane through anaerobic decomposition.

Aquatic flora and fauna adapted to a particular range of pH may no longer be able to exist within waters receiving acid drainage from peat workings. The intensity of this impact will depend on the natural acidity or alkalinity of surface water, the existing species composition and the buffering effect of groundwater and underlying rock.

## 5.5 Terrestrial ecology

Clearance of surface vegetation, the creation of access roads and the use of vehicles or other machinery on peatlands are likely to result in loss of terrestrial habitat at the peat margins and destruction or disturbance of flora and fauna within and adjacent to the working area.

Drainage and desiccation of peat may present a fire risk, due to the flammable nature of dry peat, that could destroy terrestrial habitats in or adjacent to any bog or fen.

## 5.6 Archaeology

Peatlands are a unique archaeological resource as in their formation, foliage, pollen grains, insects, invertebrates and vertebrates may all be deposited and eventually buried in the anerobic conditions of the catotelm. These may be preserved for many thousands of years and provide an indication of the prevailing climate, flora and fauna of the surrounding area at the time of their deposition. Such evidence is particularly important today when interest in long-term climatic fluctuations is high.

In some peatlands man-made wooden structures over 5,000 years old have been excavated in good condition (e.g. Meare, Somerset). Intact human remains approximately 2,500 years old have also been found (Lindow Moss, Cheshire). Such archaeological evidence could be destroyed by peat excavation, although many articles were first discovered during peat extraction, or could begin to decompose once the surrounding peat dries out.

### 5.7 Human related

Site preparation and peat extraction may cause disruption of access, noise, dust and adverse visual impacts to humans. Similarly, the increased suspended solid load of surface waters and change in colour resulting from peatland drainage may cause adverse visual and amenity impacts, particularly if a change in water quality results in eutrophication of surface waters.

## 6. Mitigation measures

The most effective mitigation measure for impacts caused by peat extraction is the increased used of alternatives to peat by horticulturists. The use of alternatives has more than doubled since the early 1980's and now accounts for almost 30% of all substrate used for horticulture (DoE, 1995). The Government has set a target for 40% of the total horticultural market requirements to be supplied by non-peat materials within the next 10 years and this should be encouraged by all interested parties.

Where no alternatives for peat are available, extraction must continue. There are few measures available to mitigate impacts on wetlands used for peat extraction as this activity entails complete physical disruption of a site. Nevertheless, impact mitigation measures may be undertaken to reduce or minimise the impact of peat extraction on adjacent surface waters. Also, it may be possible to restore worked peatland as a viable wetland habitat after extraction has taken place.

- Restoration conditions should be included in any permissions granted for peat extraction. These should aim to return a worked peatland to a viable physical and ecological configuration as a wetland habitat. Where such conditions are applied peat extraction operations should be undertaken with eventual restoration in mind.
- Peat extraction and peatland restoration must be phased to an agreed timetable, in discrete hydrological areas and to set levels. Such a schedule should allow time or create conditions for natural or assisted recolonisation.
- Working practices should follow the appropriate NRA guidelines (NRA, 1994).
- Surface waters should be diverted around any peat extraction site to reduce erosion of drainage channels.
- Peat drainage ditches should be a shallow 'U'-shape to minimise erosion and reduce the risk of ditch wall collapse.
- A peat drainage network should be designed to store as much water as possible to minimise input to surface waters.
- A sedimentation system must be used to remove suspended solids from peatland drainage waters. This may take the form of a single large pond or a series of smaller ponds. Solids suspended in peat drainage water can be reduced by a factor of x3 to x10 in this way (WRc, 1993). It is vital that settlement lagoons or ponds have sufficient capacity to cope with all conditions, including heavy rainstorms. They should be isolated from surface water runoff.
- Cutting of peat should be undertaken by block/trench cutting wherever possible as an area cut as blocks is more easily recolonised than a milled area (Smart, 1991).
- A considerable thickness of peat (e.g. 1 metre) must remain over the underlying substrate after extraction. Restoration of the chemical conditions for peat formation may be impossible without this, particularly in lowland bogs.

- 'Islands' of pristine peatland should be left intact within or adjacent to a peat extraction site, where subsurface water is available to maintain a viable wetland habitat.
- Old peat cuttings should be protected where possible as these provide refuge for bog plants that may later assist wetland restoration.
- An archaeological watching brief should be provided to monitor works and advise on procedure should any features of interest be exposed by excavation. Peat samples from different depths could be saved for future research and liaison with academic institutions for this purpose is recommended.

The restoration of peatlands is a difficult task and its success depends on a variety of factors such as the surface configuration left by peat cutting and the presence of vegetated areas that may act as a seed source. Essentially, for restoration to raised bog or fen habitat, it is necessary to minimise the sources of nutrient enrichment and to create and maintain stable hydrological conditions. Where it is not feasible to restore a site to natural peatland habitat, perhaps due to complete loss of bog flora and compression of remaining peat, it may be possible to create a different wetland type, marshland for example. Restoration of a site for agriculture or forestry should be seen as a last resort.

Detailed guidance on the restoration of raised bogs and other peatlands is beyond the scope of this note. Relevant information is provided in DoE (1995a, c, 1996).

## 7. Baseline surveys

A comprehensive survey of wetland habitats, flora and fauna would be necessary to provide baseline information for an EA of a peat extraction scheme. A detailed botanical survey should be undertaken as this will reveal the presence of rare species. Baseline information on groundwater hydraulics, surface water hydrology, chemistry and ecology will also be required.

## 8. Monitoring

An appropriate monitoring strategy should be designed and implemented to confirm the predicted impacts of any peat extraction scheme on water quality, sediment distribution and the flora and fauna of wetland habitats. Periodic on-site supervision of working practice by an environmental specialist should be arranged, so the effectiveness of mitigation measures can be assessed. Monitoring by an archaeological specialist may also be necessary within sites thought to contain deposits of interest.

Where restoration conditions have been placed on a peat extraction scheme, it will be necessary to monitor a site for many years in order to demonstrate the effectiveness of restoration work. Guidance on the monitoring of peatland restoration work is provided by English Nature (1995).

## 9. References and guidance

British Dragonfly Society (1991) *Peatlands and their Value. Evidence Presented to the Plantlife Commission of Enquiry into Peat & Peatlands*, 27th November, Glasgow.

Department of the Environment (1994) *Report of the Working Group on Peat Extraction and Related Matters*. HMSO, London.

Department of the Environment (1995a) *Guidelines for Peat Provision In England Including the Place of Alternative Materials*. Mineral Planning Guidance 13, HMSO, London.

Department of the Environment (1995b) *Preparation of Environmental Statements for Planning Projects that Require Environmental Assessment: A Good Practice Guide*. HMSO, London.

Department of the Environment (1995c) *Restoration of Damaged Peatlands with Particular Reference to Lowland Raised Bogs affected by Peat Extraction*. HMSO, London.

Department of the Environment (1996) *Reclamation of Damaged Land for Nature Conservation*. HMSO, London.

English Nature (1995) *Monitoring Rehabilitation Work on Lowland Peatlands*. English Nature, Peterborough.

National Rivers Authority (1994) *Pollution Prevention Guidelines: Works In, Near or Liable to Affect Watercourses*. PPG 5, NRA, Bristol.

Royal Society for the Protection of Birds (1993) *Out of the Mire: A Future for Lowland Peat Bogs*. RSPB, Sandy, Bedfordshire.

Smart, J. (1991) *Evidence presented to the Plantlife Commission of Enquiry into Peat & Peatlands*, 27th November, Glasgow.

Water Research Centre (1993) *The Effects of Peat Extraction on Water Quality*. WRC.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF BAIT DIGGING

Due to the relatively minor issues associated with this topic area, a Further Guidance Note was not considered necessary. Please refer back to "Scoping Guidance for the Environmental Assessment of Projects".

## NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF PEST SPECIES CONTROL

Due to the relatively minor issues associated with this topic area, a Further Guidance Note was not considered necessary. Please refer back to "Scoping Guidance for the Environmental Assessment of Projects".

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF CANAL RESTORATION

## 1. Introduction

This guidance note seeks to identify the impacts of canal restoration on the water environment. It is intended to act as a scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impacts studies of such developments. The NRA has an interest in canal restoration due to its statutory responsibilities under the Water Resources Act 1991 (WRA) for navigation in some inland waters, fisheries and protection of the water environment, particularly in respect of water resources, water quality and conservation. The Act also lays down a general duty for the NRA to promote the recreational use of inland waters and associated land.

Construction of canals in the UK took place predominantly between 1750 and 1830, although some were built much earlier and others later. The majority of these are regulated and managed by a number of authorities including British Waterways, which currently owns 2,012 miles of canals, representing 52% of the canal network in Britain.

Canals represent an important recreational, commercial and environmental resource. Some support heavy freight transport and over sixty million tons of goods are moved on inland waterways in Britain each year. Those which do not carry heavy boat traffic often support a diverse flora and fauna that includes nationally scarce species. The floating water-plantain, for example, is largely confined to the canal system and is listed on Annex 1 of the EC Habitats Directive. The conservation importance of canals is recognised by the statutory conservation agencies who have notified 65 canal related Sites of Special Scientific Interest in Great Britain.

Canals that have received little or no use or maintenance for a long period of time often become heavily silted and congested with vegetation. The infrastructure of such canals may be in a poor state of repair. Waterways in this condition may be restored to improve their navigation, fisheries, wildlife or recreation potential. Restoration may take the form of large-scale projects, involving dredging, lock or tunnel renovation, bank protection, refurbishment of brick or stone walling and vegetation management. Smaller renovation projects may be concerned with improving access to canals, tow-path renewal and the provision of moorings, landings and canal-side facilities for users.

This guidance note examines the impacts of major canal restoration works on the water environment. It does not deal with the impacts of marina development, provision of navigation facilities or canal bank protection as these are described in other guidance notes of this series. Other guidance notes that may be relevant to canal restoration are:

- Guidance Note 3 - Marinas
- Guidance Note 28 - Navigation Works
- Guidance Note 31 - Channel Works (incl. fluvial dredging)
- Guidance Note 32 - Bank Protection

## 2. Development control

Canal restoration works proposed by inland navigation authorities or their lessees, such as canal companies etc., fall under the Town and Country Planning (General Permitted Development) Order 1995 (SI 1995 Nº 418) for the purpose of development control. This allows permitted development rights to these statutory undertakers for the improvement, maintenance or repair of an inland waterway, canal or towing path. This includes the repair or maintenance of a culvert, weir, lock, aqueduct, sluice, reservoir, let-off valve or other work used in connection with the control and operation of such a waterway. The authorising body for such works is the Ministry of Agriculture Fisheries and Food (MAFF). Similar permitted development rights are given to statutory undertakers in respect of inland waterways (other than a commercial or cruising waterway) to which section 104 of the Transport Act 1968 applies.

Permitted development rights are provided by SI 418 to statutory undertakers for development on operational land in connection with the movement of traffic by canal or inland navigation. These rights are also provided for the use of any land for spreading of any dredged material.

All canal works undertaken by developers who are not statutory undertakers as defined in the 1990 Town and Country Planning Act will require local authority development consent. Planning consent may be required for the disposal of dredging spoil from canal restoration works. Developers should consult with their Local Planning Authority and Waste Regulation Authority to determine if consents are required for spoil disposal.

## 3. Environmental Assessment

The restoration of canals is not subject to any statutory requirement for Environmental Assessment (EA). It is nevertheless good practice to undertake such an assessment. The NRA, is the competent authority for determination of consent for water abstractions, land drainage and also for navigations and developments in some waters. As such, it may request certain information be made available in order to determine a consent. Such information may be necessary for the NRA to fulfil its obligations toward protection of the water environment, flood defence and the conservation and enhancement of natural beauty in respect of proposals relating to its functions. Where a development proposal associated with canal restoration is likely to require NRA consent, an EA may provide the most appropriate means by which a developer can present relevant environmental information. This could follow the guidelines prepared by the Department of the Environment (DoE, 1995) in relation to development projects.

## 4. NRA consents/licences

The NRA is the licensing authority for water abstraction under the 1991 Water Resources Act. This includes abstraction from natural underground storage and from all surface waters above the tidal low water mark. A proposal for canal restoration is likely to require an abstraction licence.

Canal restoration or enhancement works may require prior consent from the NRA under the 1991 Land Drainage Act. This will depend on the type of work to be undertaken and prospective developers should contact the NRA at an early stage in project planning to discover if Land Drainage Consent will be required. Consent under Land Drainage Bylaws may also be applicable in some areas.

Consent from the NRA is required before a herbicide can be used in or near water. If permission is granted the onus is on the herbicide user to ensure that the interests of other water users are not adversely affected.

## 5. Major potential impacts

The restoration of a canal may provide many social and economic benefits to an area and also contribute to the local archaeological heritage. These positive impacts are not dealt with in much detail here as this guidance note concentrates primarily on potential impacts of canal restoration on the water environment. Nevertheless, the social and economic benefits of canal restoration should be identified and evaluated in any EA.

### 5.1 Water resources/flood defence

Widening or deepening of any waterway and subsequent filling with water is likely to make additional demands on local water resources. Where abstraction from surface or groundwater is used in the water management of a canal this may cause reduction of flow in local rivers or change in groundwater level. The use of a canal by boats may transfer a considerable volume of water from one river catchment to another.

Where canal restoration creates or extends a raised bund within a river floodplain, this will reduce floodplain capacity and may act as a formidable barrier to lateral or downstream movement of flood waters. In some situations however, canals restoration may act as a positive aid to the downstream movement of flood water. The implication of canal restoration on local water resources, land drainage and flood defence must be addressed in an EA of such a scheme.

### 5.2 Water quality

Dredging is likely to form a part of most canal restoration works. This will cause silt disturbance that may result in increased water turbidity. Where dredged material consists of organic silts and/or plant debris, de-oxygenation of the water may occur. Sediments in canals within industrial areas may be contaminated by heavy metals, oil or other organic pollutants (Bromhead & Beckwith, 1994). The re-suspension of these compounds can cause short-term deterioration in water quality within a waterway. Fine particulates or dissolved pollutants may be carried into other water channels. The 'first flush' of water through a newly-restored canal that contained contaminated sediments is likely to be especially polluting. In the longer term, the removal of contaminated and organic sediments from a canal should lead to an improvement in water quality.

Activities such as waterway wall repairs, lock gate renewal and tow path surfacing will involve the use of cement, paint, tar macadam etc. These substances are highly polluting and could cause localised contamination if, by accident or poor working practice, they are allowed to enter surface waters.

Disposal of aquatic or bankside vegetation after cutting is likely to cause some adverse impact. If they are dumped into a waterway they may act as a physical obstruction to water flow and also, in decomposition, cause de-oxygenation of the water. The nutrient content of such cuttings may cause algal blooms to occur with consequent adverse effects on water quality. If bankside vegetation cuttings are left *in situ*, they may suppress floral diversity by encouraging rank species. Also, surface water runoff may carry decomposing material to a watercourse and cause enrichment and de-oxygenation. If vegetation cuttings are burnt this may cause air pollution, nuisance to human beings and localised destruction of marginal and riparian species and/or habitat.

### 5.3 Aquatic ecology

Increased water turbidity, decreased levels of dissolved oxygen and suspended contaminants that may be associated with dredging activities may disturb or displace aquatic flora and fauna adjacent to any working site. Fish spawning may be interrupted and fish eggs or juveniles damaged by sediment excavation or material deposition. Increased suspended sediments during dredging operations may cause direct damage to fish gills and cause suffocation. These may also reduce light penetration in water and coat vegetation, thereby reducing photosynthesis and plant growth at canal margins. These adverse impacts should be short-lived however, and if canal dredging also involves the creation of marginal habitats, the long-term impact on aquatic ecology is likely to be beneficial.

The potential ecological impacts of canal dredging depends on the techniques used. If the hard bed of a canal is unbroken by dredging then plants recover quickly; if the bed is destroyed but silt accumulates then plants may invade (Haslam, 1978). However, if the substratum of a waterway is unstable following dredging, and there is no associated sediment deposition, then vegetation returns only very slowly (Brookes, 1988).

Heavily silted canals may contain emergent vegetation such as reeds and rushes that provide a valuable feeding and breeding habitat for invertebrates, amphibians, small mammals, fish and waterfowl. Dredging, weed clearance or herbicide use will remove this shelter and food resource for wildlife. Aquatic or marginal plants of high conservation value could be lost. The intensity of impact on aquatic wildlife caused by dredging or vegetation removal will depend on the timing of such actions in relation to the growing/reproductive seasons.

### 5.4 Terrestrial ecology

The creation and use of access routes during canal restoration may disturb or destroy terrestrial fauna and flora, as may the use of heavy machinery. Habitats adjacent to a canal, such as bankside vegetation, may be lost entirely and compaction of topsoil is likely to occur. Of particular concern is the possible destruction of mature trees and other vegetation which offer shade to a waterway, as loss of shade may increase water temperature. Unfelled trees may be damaged by comprehensive trimming and lopping of branches to allow access or their roots broken by heavy machinery.

Spoil disposal is a major component of dredging operations and may pose serious environmental problems as such material may be contaminated. If spoil is dumped adjacent to a canal, potential impacts include complete destruction of terrestrial habitat, loss of visual amenity, long-term sediment input to the waterway and bank instability. If spoil is removed to another site, its transport may cause considerable noise and dust impacts to local residents. Spoil transport may also cause impacts at the receiving site, which should be investigated in an EA of such proposals.

Where a herbicide is used as an indiscriminate spray for bankside clearance in canal restoration it is likely to kill all vegetation within the working area, including rare species, those of value as a wildlife food or nesting resource and those acting to stabilise a canal bank. Leakage, spillage and careless disposal of empty containers may also cause harm to terrestrial vegetation and, if herbicide should enter surface waters, to the aquatic environment.

### 5.5 Landscape/Archaeology

Many activities involved in canal restoration, such as the use of machinery, canal dredging, spoil disposal and vegetation cutting and disposal, are likely to cause an adverse visual impact on the landscape during the course of restoration work. These impacts should be short-term only and if canal restoration is undertaken in a manner sympathetic to its surroundings, the long-term impact on landscape character is likely to be highly beneficial.

Canal restoration may provide a considerable beneficial impact to the historic and archaeological heritage of the water environment. This should apply where the development is in either a rural or an urban setting.

### 5.6 Navigation

Although in some cases canal restoration works may cause short-term restrictions on the navigable use of a waterway, canal restoration is likely to provide considerable positive benefits to navigation, providing that necessary associated facilities such as mooring points and utility services are available.

### 5.7 Human related

Canal restoration works may cause disturbance and disruption to local residents, businesses and users of the area. This may be caused by noise or dust emanating from restoration activities, or by closure of roads or footpaths while works are undertaken. The works may result in a temporary loss of amenity for any canal users and boat moorings or other facilities may be made inaccessible for a time.

Canal restoration can provide an important recreational and amenity resource in both rural and urban situations. Such development may bring positive benefits to boating enthusiasts, anglers, ramblers, nature conservation interests and local residents. It may also prove beneficial to a local tourist economy, particularly in rural areas. Appropriate facilities, such as car parks, toilets etc. must be provided and the impact of these should be examined in an EA.

## 6. Mitigation measures

A comprehensive guide to construction and management practices that may cause least impact to the water environment or that may benefit wildlife is provided by *The New Rivers and Wildlife Handbook* (RSPB *et al*, 1994). Although this publication is primarily concerned with the riverine environment, it contains much information that will be relevant to the design and implementation of a canal restoration project.

- On site supervision of working practices should be undertaken; these should follow the appropriate NRA guidelines (NRA, 1994).
- Sensitive periods, such as the fish spawning and bird breeding seasons should be avoided.
- Restored canal banks should be designed to minimise erosion (NRA, 1991).
- Materials similar to those originally used should be used for canal wall renovation where possible. This may or may not comprise local materials.

**Dredging**

- Dispersion of sediments caused by dredging should be minimised by construction of a temporary silt and sediment trap.
- Where sediments are contaminated, dredging spoil should be treated by washing and secondary processing if necessary to remove metals and hydrocarbons before disposal.
- Spoil from canal dredging may have commercial value as a fertiliser and it should be disposed of in this manner where possible.

**Vegetation management**

- Mature trees and hedgerows should be retained where this is possible. Where vegetation is removed for works access etc., replacement planting should be undertaken with appropriate species.
- Tree surgery should be carried out with the assistance of a qualified arboreculturalist.
- Cutting or removal of aquatic or terrestrial vegetation should be timed to minimise disturbance to invertebrates and other wildlife.
- Where aquatic weeds are cleared, the remains must be collected and removed from the water. Large quantities could be taken to a waste disposal facility or composted on sites of low conservation interest where liquid from decomposition cannot enter a canal or river. Where this is not possible they should be collected in small heaps away from the water environment and either burnt or left to decompose.
- Herbicides are suitable for vegetation control near water only when no other means is practicable. Only those approved by the Ministry of Agriculture Fisheries & Food should be used. The use, storage and disposal of herbicides and their containers should be in accordance with the Control of Pesticides Regulations (SI 1986 № 1510) and *The Use of Herbicides in or Near Water* (NRA, 1995).
- The NRA must be consulted prior to herbicide use as this may be inappropriate in some locations.
- Herbicides must not be sprayed indiscriminately over canal banks. Directed treatment such as wiping or spotting of unwanted species should be undertaken. Herbicide application must only be carried out by operatives who hold a certificate of competence issued by the National Proficiency Tests Council.
- A vegetation and general maintenance program should be designed and implemented as an integral part of any canal restoration project.

**Habitat enhancement**

- A water level management plan should be designed and implemented for the benefit of wildlife.
- An appropriate landscaping scheme, including tree planting should be designed and implemented as an integral part of canal restoration.
- Areas of natural habitat should be created adjacent to the canal wherever possible.
- Creation of marginal shelves and bays should be undertaken where possible to assist habitat diversity.
- Some areas adjacent to a canal could be flooded for wetland creation.
- Grassy margins should be retained on banksides where possible to provide habitat for wildflowers.
- Bird and bat boxes can be installed on existing trees and structures. Crevices may be created in canal tunnels for the same purpose.
- Fences should be erected at vulnerable locations to reduce dumping of rubbish and debris into the canal.

## 7. Baseline surveys

Information necessary as baseline data for an EA of canal restoration projects includes:

- Survey of terrestrial and aquatic flora and fauna within and adjacent to the proposed development. This could take the form of a River Corridor Survey (NRA, 1992).
- Analysis of sediments undertaken where dredging operations are intended.
- Analysis of canal water quality.
- Survey of canal navigation and boating use.
- Survey of recreation and amenity activities.
- Survey of landscape characteristics. This could take the form of a river landscape assessment (NRA 1993).

## 8. Monitoring

An appropriate monitoring strategy should be developed and implemented to confirm the predicted impacts of the restoration works. The use of water resources should be monitored. Periodic habitat and species surveys should be undertaken in and adjacent to the canal to confirm benefits to wildlife and establishment of new habitats where this formed part of restoration work. Boats and pedestrians can be counted by automatic devices and the information used to assess the success of restoration in providing navigation, recreation and amenity opportunities.

## 9. References and guidance

Bromhead, J.C. & Beckwith, P. (1994) Environmental Dredging on the Birmingham Canals: Water Quality and Sediment Treatment. *Journal of the Institution of Water and Environmental Management*, **8** (4): 350-360.

Brookes, A. (1988) *Channelised Rivers: Perspectives for Environmental Management*. John Wiley & Son, Chichester.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide.* HMSO, London.

Haslam, S.M. (1978) *River Plants.* Cambridge University Press, Cambridge.

National Rivers Authority (1991) *Bank Erosion on Navigable Waterways.* R & D Research Project Report 225/1/T, NRA, Bristol.

National Rivers Authority (1992) *River Corridor Surveys: Methods and Procedures.* Conservation Technical Handbook No. 1, NRA, Bristol.

National Rivers Authority (1993) *River Landscape Assessment: Methods and Procedures.* Conservation Technical Handbook No. 2, NRA, Bristol.

National Rivers Authority (1994) *Works In, Near or Liable to Affect Wtercourses.* Pollution Prevention Guidelines No. 5, NRA, Bristol.

National Rivers Authority (1995) *The Use of Herbicides in or near Water.* NRA, Anglian Region, Peterborough.

Royal Society for the Protection of Birds, National Rivers Authority, & Royal Society for Nature Conservation (1994) *The New Rivers and Wildlife Handbook.* RSPB, Sandy, Beds.

# NRA GUIDANCE NOTE ON THE ENVIRONMENTAL ASSESSMENT OF MARINE DREDGING

## 1. Introduction

This guidance note seeks to identify the impacts of marine dredging on the water environment. It is intended to act as a general scoping brief to convey the concerns of the National Rivers Authority (NRA) in environmental impact studies of marine dredging activities. The NRA has several interests in the potential impact of marine dredging. It bears a statutory responsibility for preserving and improving the quality of coastal waters (which extend to three nautical miles from the shore) under the Water Resources Act 1991 (WRA). This Act also requires the NRA to maintain and preserve salmon, trout and eel fisheries within coastal and inland waters. The Authority bears operational responsibility for sea defence under the WRA and Land Drainage Act 1991 in areas not under the administration of Internal Drainage Boards. It has a general duty of supervision over all sea defences and can act in default of other authorities.

The UK marine sand and gravel industry supplies approximately 13% of the nation's demand for sand and gravel, with total landings of around 12 million tons per annum. The main dredging areas are on the east and south coasts of England, although sand dredging also takes place along the western coasts of England and South Wales.

Marine dredging for aggregate extraction is undertaken from a vessel using some form of pumping technique. A suction pump can be used in very shallow water (to 30m below the level of a pump) but many existing licenced reserves lie beyond this depth. Gravel can be extracted from a greater depth by jet pumps, air-lift pumps or in-line pumps, which provide a dredging capability of 50m or more. Of the material excavated, any unwanted fraction is usually rejected overboard.

Aggregates obtained by marine dredging are landed at wharves in coastal, estuarine and inland waters. Although the construction and use of such facilities and the movement of dredging vessels in inland waters are relevant to various functions of the NRA, this guidance note deals only with the potential impact of dredging operations. Issues arising from the construction of facilities and movement of vessels are examined in other guidance notes of this series, specifically:

- Guidance Note 1 - General Construction;
- Guidance Note 28 - Navigation Works.

## 2. Development control

Dredging for minerals in coastal waters requires approval and consent from the Crown Estate Commissioners. Before granting a licence, the Commissioners seek the views of interested bodies, including the NRA, and requests a 'Government View' from the relevant co-ordinating Government Department, which is either the Department of the Environment or the Welsh Office.

## 3. Environmental Assessment

The exploitation of mineral resources is identified in Annex II of the EC Directive 'The Assessment of the Effects of Certain Public and Private Projects on the Environment' (CEC, 1985). The requirements of the Directive were incorporated into the Government View Procedure in 1989. As such, Environmental Assessment (EA) of these developments may be required if a project is deemed likely to have a significant effect on the environment by virtue of its nature, size or location. The decision as to whether an EA should be conducted lies with the co-ordinating Government Department.

Whether or not a formal EA of a proposed marine mineral extraction scheme is required by the co-ordinating Department, it may prove worthwhile for a developer to undertake some form of assessment. The NRA, as an interested party to the mineral extraction licensing procedure, may request environmental information concerning a proposal. Such information may be necessary in order for the NRA to discharge its statutory responsibilities for sea defence, fisheries and conservation and enhancement of the water environment. An EA may provide the most appropriate means by which a developer can collate relevant environmental information.

It is suggested that the conduct of an EA and subsequent preparation of a formal Environmental Statement or informal report should follow the guidelines prepared by the Department of the Environment (DoE, 1995). Although these are designed primarily to illustrate good practice in EA of development projects on land, they are relevant to any type of EA.

## 4. NRA consents/licences

No NRA consents or licences are applicable to the dredging phase of sea-bed mineral extraction.

## 5. Major potential impacts

The direct impacts of aggregate extraction on the marine environment will be largely physical, due to the removal of material and possible change in sediment topography and type. There may also be biological impacts, both direct and indirect. These are described below under headings of major environmental components. As licenced dredging grounds and operations tend to be in groups, the cumulative impact of dredging should be considered in any EA of an individual scheme. Other guidance, such as *Guidelines for assessing marine aggregate extraction* (MAFF, 1993) may also prove useful in identifying issues of concern within an EA of dredging operations.

### 5.1 Marine hydraulics

Where dredging operations create holes or trenches on the seabed, the irregular relief can substantially alter the existing inshore wave refraction and current patterns, particularly in shallow water. In turn this may exert an impact on erosion of the coastline or coastal flood defences. Although no coastal erosion has been scientifically attributed to the effects of dredging (DoE, 1986) a relationship between the two is believed to exist. Where dredging grounds are close to shore the possibility of changed marine hydraulics causing an impact on coastal stability should be investigated in an EA.

## 5.2 Water quality

### Turbidity

Sediments disturbed by dredging operations may be suspended in the water column, thus increasing water turbidity. While sand may fall rapidly to the seabed, silt and clays are capable of remaining in suspension for longer periods. Some impairment of water quality can be expected to persist in the short-term, i.e. for some hours while dredging takes place, and also over a longer time period of tens of years, i.e. for the lifetime of a mineral extraction project. The intensity of impact on water quality will depend on the amount and physical/chemical characteristics of suspended sediments, local hydrographic conditions and the existing turbidity regime.

Natural turbidity levels vary both with location and wave or tide conditions. Four broad offshore turbidity regimes are recognised (DoE, 1986):

1) Clear water (c. 5mg/l), muddy seabed, low energy environment;
2) Clear water, coarse seabed, high local energy environment;
3) Turbid water (c. 100mg/l), coarse seabed, high energy environment;
4) Turbid water, muddy seabed, moderate to low energy environment.

Regimes 1) and 4) are not currently worked for aggregates in the UK because of the presence of mud overburden. Should this situation change, these areas are likely to produce a large volume of fine suspended sediment if disturbed by dredging operations.

### Dissolved oxygen

The organic content of buried fine sediments will usually have a high biochemical oxygen demand (BOD). When such particles are suspended in the water column they are likely to deplete local levels of dissolved oxygen. In muddy deep pits in static water this could lead to near-anoxic conditions and a high level of dissolved hydrogen sulphide. However, the mixing conditions of British waters are considered sufficient to ensure most dredging operations would not generate such extreme effects (DoE, 1986).

### Contaminants

Fine sediments act as a sink for many pollutants introduced into the marine environment. Dredging operations may cause re-suspension of such contaminants. This may be a particular cause of concern where potentially toxic material such as sewage sludge or industrial wastes have been dumped at sea in an area now licenced for mineral extraction.

Where sea bed material contaminated with heavy metals is pumped ashore for beach recharge or a reclamation project and subject to rainfall and drainage, the resulting change in redox potential and pH can release the heavy metals from the sediment. This could pose a risk to the quality of inland surface or inshore coastal waters.

## 5.3 Marine ecology

Marine dredging may destroy or disturb existing marine benthic habitats directly, through excavation or burial, or indirectly through alteration of marine currents or water quality. Some dredging grounds, in the Severn estuary for example, may be adjacent to areas important for marine wildlife, as identified by English Nature (1994).

Destruction of benthic fauna and flora results primarily from the direct action of a draghead and pump. Some animals and plants may remain in the cargo but most are returned to the sea as organic detritus. These will include all types of algae, small invertebrates, echinoderms, crustaceans and vertebrates. If trailer dredging is employed, a large area of sea bed may be sterilised in this way each year. After dredging has been completed in a particular area, the exposed strata may be clay, rock or mobile sand, with a poor recolonisation potential. In such cases the destruction of marine habitat may be considered permanent.

Where dredged aggregate is selected by size at the draghead, a change in sediment characteristics can be expected as a result of dredging operations. The residual deposit left on the seabed at the termination of a dredging scheme is likely to consist largely of cobbles and boulders. This will influence the characteristics of any flora and fauna recolonising the area.

Where medium and course sand is screened at sea and rejected overboard, marine habitats in the vicinity are likely to suffer from some degree of burial from this material. Tide and wave action may further transport these particles, forming sand megaripples, ribbons and sheets, which are all largely ecologically sterile substrates (DoE, 1986). Fine sand or silt disturbed by dredging or washed overboard with hopper overflow water have the greatest potential for dispersion. Settlement of these small grains on the seabed may cause in-filling of crevices in gravel or cobbles that act as habitat for small invertebrates.

Increased turbidity caused by dredging can affect many biological processes. It may cause a decrease in algal photosynthesis and in the hunting capability of fish and marine birds. The food intake of filter-feeding zooplankton and benthic invertebrates may decrease as the ratio between edible plankton and inedible silt is disturbed (Adriaanse & Coosen, 1991). Large quantities of suspended material may also physically damage fish gills and feeding organs of other marine life.

The potential changes in seabed ecology referred to above are likely to exert an impact on benthic productivity and the local marine food chain.

## 5.4 Fisheries

Individual mobile shellfish such as crabs, lobster, shrimps and prawns may be destroyed directly by dredging operations. Of greater concern is the possible excavation or burial of the breeding habitat of crabs, as the female congregate to incubate their eggs. Large numbers of female crabs within or adjacent to a dredging ground may be at risk from excavation or material deposition. Even where the females survive, disturbance of brooding behaviour may lead to abortion of eggs.

Sandeels bury themselves in the surface sands of the seabed and remain dormant throughout the winter months. They are often present in very large numbers on the seabed and are fished for use as fertiliser. Aggregate dredging could destroy individuals, eggs and the spawning habitat of these fish.

The behaviour of migratory fish such as salmon may be disturbed by either the noise of dredging operations or the increased water turbidity likely to prevail in the vicinity. This may result in failure to migrate to inland waters to spawn and consequent local decline in the fish population while dredging continues.

### 5.5 Human related

Marine dredging operations may interfere with inshore fisheries. This may involve operation conflict, such as damage to sets of pots, long-lines or trammel nets. Dredging could also cause long-term sterilisation of inshore bottom fishing grounds.

Where aggregates are to be off loaded at wharves in estuarine or inland situations the continuous movement of dredging vessels or barges in and out of these waters may exert an adverse impact on other water users, including those engaged in boating or sailing.

## 6. Mitigation measures

Marine dredging is inherently a destructive operation and some impacts must be accepted as an environmental cost of this form of development. Nevertheless, the incorporation of mitigation measures into a dredging scheme to avoid or reduce some of the impacts described previously is possible.

- Dredging practice for the excavation of minerals should be conducted in such a way that on cessation of dredging the grounds are able to recover ecologically. This may include not excavating the whole depth of mineral strata so recolonisation can occur and leaving 'islands' of natural habitat within a licenced dredging area to act as seeds for subsequent recolonisation.
- Mineral extraction should be undertaken in pre-determined patterns, planned to minimise impact on benthic ecology and inshore fisheries.
- Repeated trailer dredging should be carried out accurately so that a minimal area of sea bed is disturbed. This may be achieved by exact position-fixing, including monitoring systems to prevent dredging off station.
- Screening of medium and coarse sand at sea and subsequent dumping overboard should not be undertaken unless this material is used to backfill worked out areas.

## 7. Baseline surveys

The type of baseline information required for an EA of dredging operations includes:

- Detailed hydrological information, which should include data on tidal and residual water movements, wind and wave characteristics, existing suspended sediment load and storm days per year.
- Biological survey of benthic species and community structure within and adjacent to the area to be excavated should also be undertaken.
- Chemical analysis of mineral samples taken at several different depths over the whole area to be dredged to determine if contaminants are present.
- Identification of areas of scientific or biological interest, natural beauty or significant cultural or historical importance that exist within or adjacent to the proposed excavation site. Statutory designations must be identified.
- Examination of the nature and type of nearby coastline to identify areas that are vulnerable to erosion.
- A thorough and comprehensive survey of local fishing interests will be required for an EA of marine mineral extraction. This should involve consultation with MAFF, Sea Fish Committees, Fishing Associations, Fish Processors and Shellfish Processors.

## 8. Monitoring

A monitoring program to confirm the impacts of marine dredging should be designed and implemented and the effectiveness of mitigation measures assessed. Monitoring practice could include detailed seabed mapping, underwater photography of excavations and peripheral seabed, and core sampling of adjacent marine habitats.

## 9. References and guidance

Adriaanse, L.A. & Coosen, J. (1991) Beach and Dune Nourishment and Environmental Aspects. *Coastal Engineering*, **16**: 129-146.

Commission of the European Communities (1985) On the Assessment of the Effects of Certain Public and Private Projects on the Environment. *Official Journal*, L175, 28th May, Brussels.

Department of the Environment (1986) *Marine Dredging for Sand and Gravel*. DoE Minerals Division, HMSO, London.

Department of the Environment (1995) *Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide*. HMSO, London.

English Nature (1994) *Managing England's Marine Wildlife*. English Nature, Peterborough.

Ministry of Agriculture, Fisheries and Food (1993) *Guidelines for Assessing Marine Aggregate Extraction*. Laboratory Leaflet 73, MAFF, Lowestoft.

## Section 4 Legal Requirements

The legislative framework within which much of the statutory environmental assessment is carried out by external bodies in England and Wales is that of the Town and Country Planning (Assessment of Environmental Effects) Regulations 1988 (SI 1988 No. 1199) which is available from HMSO. This implemented much of the EC Council Directive on the assessment of the environmental effects of certain public and private projects on the environment (85/337/EEC), a copy of which is enclosed at the end of this section. A number of other Regulations also implemented the Directive, as indicated in the regularly updated DoE/WO publication *Environmental assessment: a guide to the procedures* (DoE/WO 1989). Note that there are proposals to amend the Directive, and a copy of these proposals as at May 1994 are also included at the end of this Section.

The legislative framework within which the NRA operate is primarily that of the Water Resources Act 1991 (WRA 1991). As such, the Act largely determines responses to development proposals and applications for licences/consents. In the context of EA, relevant sections of WRA 1991 are summarized below.

### 4.1 General duties and functions

In general, Section 2 of the Act establishes the functions of the NRA with respect to: water resources; water pollution; flood defence and land drainage; fisheries; and navigation. The section also lays down the general duty to promote conservation and recreation. Later sections of the Act define NRA duties and powers in more detail.

### 4.2 Water resources

The legislation with respect to water resources and the responsibilities of the NRA are laid down in sections 19 - 84 of the WRA 1991.

The NRA's responsibility for the general management of water resources is set out by the duty under section 19 to take action as considered necessary for the purposes:

- of conserving, redistributing or otherwise augmenting water resources in England and Wales; and
- of securing the proper use of water resources in England and Wales.

The power to ask the Secretary of State to set minimum acceptable flows, levels or volumes for inland waters is set out in section 21.

The restrictions applying to water **abstraction** are set out in section 24. Without a licence or outside the provisions of a licence it is an offence to:

- abstract water from any source of water; or
- cause or permit any other person so as to abstract any water.

In respect of groundwater abstraction, it is similarly an offence, without a licence or consent, to:

- construct any well, borehole or other work by which water may be abstracted from those strata;
- extend any such well, borehole or other work; or
- install or modify any machinery or apparatus by which additional quantities of water may be abstracted from those strata by means of a well, borehole or other work.

Section 25 of the WRA 1991 sets out the restrictions applying to **impounding** water. It is an offence, without a licence, to construct or alter any impounding works at any point in any inland water that may obstruct or impede the flow of that water.

Note that under section 26, navigation, harbour and conservation authorities are exempt from the restrictions on abstraction and impounding works in the carrying out of their functions as such an authority. Exceptions to the restrictions applied to abstraction also occur under section 27 for cases of small-scale abstractions and those for domestic supply, and under section 29 for abstraction for the purpose of land drainage.

Licensing arrangements are covered by a number of sections of the WRA 1991. The NRA *Licensing Manual (Water Resources)* explains these in some detail.

### 4.3 Water quality/pollution control

The NRA's management of water quality is based on legislation with respect to the control of pollution of water resources.

Under the WRA 1991, the Secretary of State for the Environment has powers to set up a system for classifying water quality (section 82) and to establish Statutory Water Quality Objectives for controlled waters(section 83). The NRA is then under a duty under section 84 to use its powers to ensure that these objectives are achieved and must monitor the extent of pollution.

Under section 85 of the WRA 1991, a pollution offence occurs if a person knowingly permits:

- any poisonous noxious or polluting matter or any solid matter to enter any controlled waters;
- any matter, other than trade effluent or sewage effluent, to enter controlled water by being discharged from a drain or sewer in contravention of a prohibition notice;
- any trade effluent or sewage effluent to be discharged into any controlled water or from land, through a pipe, into the sea outside the seaward limits of controlled waters;
- any trade effluent or sewage effluent to be discharged, in contravention of a prohibition notice, from a building or from a fixed plant onto or into any land, or into any waters of a lake or pond which are not inland freshwaters; or
- any matter whatever to enter any inland freshwaters so as to tend to impede the proper flow of the waters

Under section 86 the NRA may impose prohibition notices to prohibit discharges being made or continued. Depending on the nature of the notice, it can be an offence to contravene such a notice by making a discharge or failing to meet the specific conditions of a notice. Discharges containing a prescribed substance or those from a prescribed process also will be in contravention of a prohibition notice.[1]

Sections 88 and 89 of the WRA 1991 sets out the conditions under which discharges may be made, and hence an offence of polluting controlled waters does not occur. As such, the NRA permits and controls discharges primarily through a system of discharge consents.

### 4.4 Flood defence

The WRA 1991 sets out the NRA's duties with respect to flood defence. The Land Drainage Act 1991 defines the responsibilities of the NRA with respect to main rivers and ordinary watercourses, the NRA having strong control over the former. Under sections 109 of the WRA 1991 and without the consent of the NRA, no person shall:

- erect a structure in, over or under a watercourse which is part of a main river;
- carry out any work of alteration or repair on any structure in, over or under a watercourse which is part of a main river; or
- erect or alter any structure designed to contain or divert the floodwaters of any part of a main river

Consents are issued by the NRA under section 110 of the WRA 1991, which also specifies that consents:

- shall not be unreasonably withheld;
- shall be deemed to have been given if it is neither given nor refused within the relevant period (i.e. two months, subject to conditions); and
- may be given subject to any reasonable condition as to the time at which and the manner in which any works is to be carried out.

### 4.4 Fisheries

Section 114 of the WRA 1991 sets out the general fisheries duty of the NRA, i.e. to maintain, improve and develop salmon fisheries, trout fisheries, freshwater fisheries and eel fisheries.

The NRA is also the competent body under Section 30 of the Salmon and Freshwater Fisheries Act 1975 to issue consents for the introduction of fish to inland waters.

### 4.5 Conservation and recreation

Under Section 2 of the WRA 1991, the NRA has a general duty to promote:

- the conservation and enhancement of the natural beauty and amenity of inland and coastal waters and of land associated with such waters;

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[1] Discharges of prescribed substances (from prescribed processes) are subject to controls by Her Majesty's Inspectorate of Pollution under the Environmental Protection Act 1990.

- the conservation of flora and fauna which are dependent on an aquatic environment; and
- the use of such waters and land for recreational purposes.

In addition, the need to further conservation is defined under Section 16 of the WRA and Section 12 of the Land Drainage Act 1991. The NRA is obliged, in formulating or considering any proposals relating to any of its functions, to:

- further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological and physiographical (landform) features of special interest;
- have regard to the desirability of protecting and conserving buildings, sites and objects of archaeological and historic interest; and
- take into account the effect which the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects.

The need to preserve public access is also defined under Section 16 of the WRA 1991, i.e. the duties when formulating or considering proposals relating to the functions of the Authority:

- to have regard to the desirability of preserving for the public any freedom of access to areas of woodland, mountains, moor, heath, down, cliff or foreshore and other places of natural beauty;
- to have regard to the desirability of maintaining the availability to the public of any facility for visiting or inspecting any building, site or object of archaeological, architectural or historic interest; and
- to take into account any effect which the proposals would have on any such freedom of access or on the availability of any such facility.

Under Section 18 of the WRA 1991 the NRA should follow codes of practice with respect to environmental and recreational duties; the current government guidance is the *Code of Practice on Conservation, Access and Recreation* issued in 1989.

# COMMISSION OF THE EUROPEAN COMMUNITIES

COM(93) 575 final
Brussels, 16.03 1994

94/0078 (SYN)

Proposal for a
COUNCIL DIRECTIVE
amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment

(presented by the Commission)

## EXPLANATORY MEMORANDUM

### 1. Justification of the proposal

This proposal for a Directive amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment[1] is submitted in accordance with Article 11(4) of the Directive, which calls upon the Commission to submit additional proposals to the Council with a view to ensuring that the Directive is applied in a sufficiently coordinated manner.

The proposal is based chiefly on the findings of the report on the implementation of the Directive[2], which the Commission, again in accordance with Article 11, sent to Parliament and the Council.

The experience gained over that period shows that, despite considerable efforts to bring existing national procedures more closely into line with the new environmental impact assessment requirements, there have been practical difficulties in implementing the Directive owing to occasional differences in interpretation between the Member States and the Commission. The latter has on several occasions found that Member States are failing to apply the Directive in its entirety.

In addition, the proposal takes account of the Community's and the Member States' international commitments under the Espoo Convention on environmental impact assessment in a transboundary context[3]: certain Articles of the Directive are adapted, including Article 7, which has been reworded in the light of the Convention's objectives.

Lastly, the proposal is a response to the concern expressed by Parliament in its Resolution on agriculture and the environment[4] and by the Commission itself in its communication on the same subject[5].

### 1.1 Report on the implementation of Directive 85/337

Detailed analysis of the information in the report on the implementation of Directive 85/337/EEC revealed that the Directive has been applied very differently from one Member State to another.

These differences particularly concern the rules in the Directive on:

- the practical scope of the Directive, as laid down by Article 2(1) in conjunction with Article 4 (Annexes I and II);
- the information to be supplied based on Article 5 in conjunction with Annex III;
- monitoring of the impact of the project.

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(1) OJ No L 175, 5.7.1985.
(2) COM(93) 28, 2.4.1993.
(3) OJ No C 104, 24.4.1992.
(4) OJ No C 68, 24.3.1986.
(5) COM(88) 338 final, 8.6.1988.

1.1.1 Scope

One of the key criteria for assessing practical implementation of the Directive are the data on the total number and types of projects assessed. These figures clearly indicate that the differences in the annual number of assessments are attributable to differences in the extent of the obligations imposed by the national legislation for Annex II projects and to the thresholds applied for such projects.

However, as currently defined in Article 4, the scope of the Directive covers both projects for which assessment is a mandatory requirement (Annex I projects) and those for which assessment must be performed only where Member States so deem necessary on the basis of the project's characteristics (Annex II projects).

Taking issue with the way certain Member States have interpreted this latter provision, the Commission believes that giving Member States this discretionary power should not devalue the general provision in Article 2(1) which requires all projects referred to in both Annexes I and II of the Directive to be assessed if they are liable to have a significant environmental impact.

As the Commission sees it, the reason for the difference in approach to Annex I and Annex II projects in Article 4 is essentially the following: whereas it is unanimously acknowledged that Annex I projects have to be subjected to mandatory systematic analysis, in the case of Annex II projects it has been agreed that the detailed arrangements for assessing environmental impact should be determined by the Member States in keeping with their individual constitutional and administrative procedures.

In this connection, the report stresses that besides the fears that Annex II projects are not fully covered, there are also grounds to fear the opposite since the adoption of very low thresholds (or no thresholds at all) could result in large numbers of relatively minor projects being submitted for assessment.

The Commission is therefore proposing to amend paragraph 2 of Article 4 so as to clarify:

(i) the circumstances in which Annex II projects will be required to undergo an environmental assessment, i.e. where they are liable to have a significant effect on special protection areas designated by Member States and communicated to the Commission in accordance with the Community Directives on environmental protection;

(ii) the selection procedure for Annex II projects which Member States must apply in all other cases in order to ascertain whether an assessment is necessary, using criteria defined and agreed at Community level. Where appropriate these criteria can be accompanied by thresholds to be laid down by the Member States in line with the principles of subsidiarity and shared responsibility.

1.1.2 Content of the impact study

The current practices for determining the information provided for in Article 5 vary considerably from one Member State to another. In most cases, however, the result is that the impact assessments contain only the minimum information required by Article 5(2), thereby failing to satisfy the requirement in paragraph 1 that the information, under certain circumstances, must be that specified in Annex III.

To ensure that the information collected is more relevant to the type of project being considered and to improve the quality of that information, the Commission believes the application of this article could be clarified by introducing the concept of scoping.

specified in Annex III should be gathered and submitted by the developer. In any event this information should include a description of the alternatives being considered by the developer.

The developer will henceforth have access to the data held by any authority, in accordance with Directive 90/313/EEC on the freedom of access to information on the environment[6], Article 3 of which requires public authorities to make available information relating to the environment to any natural or legal person at his request and without his having to prove an interest.

1.1.3. Monitoring

The report highlighted the technical shortcomings of the assessment procedure provided for by the Directive, which makes no provision for monitoring the effects on the environment due to the implementation of the project.

However, imposition of such monitoring would have a beneficial effect when it comes to implementing the project by enabling the competent authorities and the developer to take the necessary measures to soften or compensate for the impact at the earliest possible stage, thereby improving the cost-benefit ratio for the measures.

Moreover, it would enable the environmental authorities and the public to take a more favourable view if the impact assessments revealed uncertainties or gaps in the information about a project since they could be reconsidered during the monitoring phase.

A clause to this effect has already been included in the Espoo Convention which the Member States and the Community must observe as regards the transfrontier impact.

However, the Commission considers that there is no need, at the moment, to adapt the Community Directive to the rules laid down in the Directive, by providing for systematic monitoring of the circumstances in which the development consent decision was taken and the proposed corrective measures so as to avoid, reduce or offset the adverse effects on the environment.

Before submitting specific proposals it intends to examine in greater depth the costs and benefits of such adaptation and its compatibility with the subsidiarity principle.

1.1.4. These new provisions are consistent with the experience of environmental assessment at international level and in a number of Member States. They should, in the Commission's view, make this procedure more efficient and yield greater benefits in terms of safeguarding the environment.

1.2 Compatibility with the fifth environmental action programme and with the White Paper on growth, competitiveness and employment

The fifth programme acknowledges the central role of the environmental impact assessment in decision-making with regard to both individual projects and the underlying development strategies.

[6] OJ No L 158, 23.6.1990.

It provides decision-makers with the information needed in order to evaluate the environmental impact of the necessary investment more accurately, especially in the sectors which are given priority in the fifth programme[7] and in the White Paper on growth, competitiveness and employment[8].

In particular, the rules in force and those proposed enable the Member States to take the appropriate measures to simplify and concentrate the existing national consent procedures and to avoid unnecessary delays during planning and implementation of priority projects identified and adopted at Community level, particularly as part of the trans-European networks.

More systematic and better coordinated application of the EIA procedure can also help reduce distortion to which the widely differing national practices may give rise.

2. Costs and benefits of the proposal

2.1. The potential benefits of the new provisions, which are explained in detail under point 1.1, are considerable:

- more relevant and selective gathering of the information required from the developer based on the particulars supplied by the competent authority in agreement with the environmental authorities responsible and in consultation with the developer. It should be emphasized here that involving the public in appropriate ways at this stage of the assessment procedure can only improve public relations and make the necessary consensus on the project easier to achieve;

- easier access to relevant existing data for those who need it;

- better control over the quality of impact assessments and the conclusions drawn from them;

- closer attention to attenuation measures which tend not to be properly integrated into the project design;

- fewer assessments of very small projects (where they are unlikely to have any environmental impact).

2.2. The cost of putting these new measures into effect can be broken down into three categories: funding, time and personnel. Since these three parameters will be dependent on the number and type of assessments to be conducted, it is impossible to put forward accurate estimates at this stage.

Experience gained in the Member States shows that generally the financial cost of conducting an impact assessment is a minute fraction of the total project cost. Only in exceptional cases for small projects requiring heavy capital investment will they be more than 1% of the total cost of the project[9].

It therefore seems perfectly reasonable to assume that normally the cost of such an assessment will remain below the 1% threshold.

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(7) COM(92) 23 final, 12.6.1992, pages 26-27.

(8) COM(93) 700 final, 5.12.1993.

(9) See Report on the implementation of Directive 85/337/EEC (COM(93) 28 final, pp. 55-57).

The cost of attenuation measures varies appreciably from one project to another and is usually dictated by environmental constraints. Where the environmental protection standards to be attained are the same, the necessary attenuation measures can be taken into account from the beginning of the project design, which should permit a reduction in the overall capital cost.

Similarly, the time taken for the environmental impact assessment seems to make little difference to the total time needed to implement the project as it can be included in the consent procedure.

Secondly, it is clear that the time required for the scoping exercise, if it is well managed, will be more than offset by savings at later stages in the development consent process.

2.3. Lastly, given that the implementation of these provisions will create certain additional needs in terms of training people to conduct assessments and in terms of drafting appropriate guidelines, the Commission has already initiated a programme of technical assistance to that end in conjunction with the Member States.

3. Subsidiarity and proportionality

3.1. The main purpose of harmonizing the provisions on environmental impact assessment is to establish at Community level a general frame of reference to ensure that action by Member States to protect the environment is following similar lines.

The same is true of the new provisions contained in this proposal, insofar as the proposed amendments do not alter the actual scope of the Member States' obligations under the directive.

It is for the Member States, working within their own administrative and organizational structures, but on the basis of principles laid down at Community level, to:

- define the required content and form of the information to be supplied by the developer;
- explain the manner in which the outcome of the assessment is taken into consideration;
- examine, in certain circumstances, whether the likely environmental impact of Annex II projects makes an assessment necessary.

3.2. Consequently, these provisions are consistent with the principle of subsidiarity enshrined in Article 130r of the Treaty and restated in the fifth environmental action programme.

4. Consultation of socio-economic interests

Consulting the Economic and Social Committee under Article 198 of the Treaty will guarantee a wide-ranging debate with the representatives of the various economic and socio-professional groups.

5. Legislative situation in the Member States

Although the new provisions on screening and scoping have not yet been fully incorporated into the laws of the Member States, some of the practices involved are already being applied to differing degrees in a number of Member States, and in certain non-Community countries. The following tables give an idea of the experience gained and the extent to which the procedures mentioned above, and monitoring have been formalized.

## TABLE A

### LEGISLATIVE SITUATION IN MEMBER STATES REGARDING SCREENING, SCOPING AND MONITORING

| MEMBER STATES | SCREENING | SCOPING | MONITORING |
|---|---|---|---|
| Belgium | Single list of projects subject ot EIA in Flanders (1 & 2 of EIA admin orders)<br>Wallonia more individual evaluation of projects to assess requirement for EIA. | No mandatory provision in Flanders regulation.<br>Public enquiry provided for projects initiated by a public body. | Industrial installations conditions of licence may require that monitoring is carried out. |
| Denmark | Lists of projects requiring EIA in several Acts; no screening procedure. | No mandatory provision<br>Informal discussion in EIS preparation. | Local authorities undertake monitoring requirements as part of planning process. |
| Netherlands | List of projects requiring EIA in annex C of EIA Decree; no screening procedure. | Competent authority draws up guidelines after mandatory consultation of other authorities, independent EIA Commission and the public. | Regulations require monitoring of effects detailed in EIS. |
| Greece | Two list of projects (Group 1 & Group 2); all projects require EIA but the two groups have different EIS content requirements; no screening procedure. | No formal provision at present.<br>Binding arrangements in preparation. | Only occasional monitoring and post-auditing undertaken by PERPA. |
| Germany | Lists of projects requiring EIA at both federal and regional (Lander-) level; screening of significance of effects in the case of modification to projects. | Discussion of information requirements between developer and competent authority mandatory at federal level; in some "Lander" mandatory public consultation. | Some projects monitored, under EIA act and consent agency may require additional monitoring. |
| Ireland | Single list of projects; EIA mandatory when project above threshold, case-by-case screening possible when under threshold. | No formal provision at present.<br>Proposed EPA to prvide scoping guidelines for EIS information on project classes. | No formal system for monitoring under EIA regulations.<br>Proposed EPA may have a monitoring and evaluation rôle. |
| Italy | Single list of projects requiring EIA; no screening procedure. | No mandatory provision. | Consent may be conditional on formation of monitoring network. |
| France | Lists of projects requiring EIA in several Acts; no screening procedure. | No mandatory provision for formal, systematic scoping. | All "installations classées" subject to monitoring by relevant inspectorates. All other projects not subject. |
| Portugal | Annex of D.L. No 38/90, project list and thresholds (24 types of projects). | No mandatory provision. | No formal provision for monitoring. |
| Spain | Lists of projects requiring EIA in several acts, both at the national level and the level of autonomous communities (lists of additional projects requiring EIS); no screening procedure. | | Voluntary scoping only (takes place in most cases). Monitoring required by programme of Environmental Surveillance. Conditional in declaration of Environmental Impact. |

| | | | |
|---|---|---|---|
| UK | No mandatory thresholds/criteria; UK legislation provide for case by case consideration of projects by competent authorities | No mandatory provision<br>Developer/competent authorities consultation recommended by DoE<br>No mandatory provision, but monitoring conditions may be attached to certain consent procedures | |
| Luxembourg | Projects covered by "commodo Law" (Annex I & most of Annex II) are screened for full-EIA requirement on the basis of preliminary EIA, other projects case-by-case screening | No formal provision for scoping, check lists drawn by CA for specific projects. No new legislation envisaged | Some monitoring carried out under the "commodo-law" |

TABLE II

## LEGISLATIVE SITUATION REGARDING SCREENING, SCOPING AND MONITORING IN COUNTRIES CANDIDATE FOR THE MEMBERSHIP OF THE UNION

| COUNTRY | SCREENING | SCOPING | MONITORING |
|---|---|---|---|
| Austria | Single list of projects | Competent authority, after consultation of other authorities & public, decides on acceptability of a draft EIS content proposed by the developer | Mandatory monitoring under the responsibility of the competent authority; results must be communicated to other authorities |
| Finland (NB. proposal for EIA Act) | Single list of projects; in addition possibility for a case-by-case screening by Minister of Environment | The competent authority decides, following public consultation and involving the developer, on the content of the EIS | Monitoring of projects mandatory under sectoral acts; monitoring programme mandatory part of EIS; monitoring information is public |
| Norway | Single list of projects in principle requiring EIA; for projects not listed possibility of case-by-case screening by Minister of Environment. | The competent authority decides, after consultation of public and Minister of Environment, on the need for a full EIS and sets guidelines for its content. | Monitoring programme mandatory part of EIS; competent authority establishes programme, after consultation of public & Minister of Environment; programme responsibility of developer. |
| Sweden | In principle, according to the Natural Resources Management Act, all projects needing a permit under 13 different Acts require EIA. | Each Competent Authority has the power to determine the scope of each assessment but scoping procedures are not yet contained in legislation. | No specific EIA provisions or procedures for monitoring. Some more general provisions for monitoring project implementation may exist under specific permitting procedures. |

## TABLE C

### LEGISLATIVE SITUATION REGARDING SCREENING, SCOPING AND MONITORING IN CERTAIN COUNTRIES

| COUNTRY | SCREENING | SCOPING | MONITORING |
|---|---|---|---|
| Canada | Yes | Yes | Yes |
| United States | Yes | Yes | Variable - only in certain cases |
| New Zealand | Yes | No | Yes |
| Australia | Yes | Yes | Variable - generally no |
| Switzerland | Yes | Yes | No specific provision in ordinance |

6. Legal basis

The main reason for choosing Article 130s(1) was the fact that the Directive dates back to 1985 when it was based on Article 100, in view of the distortion which could arise from the diverging impact assessment requirements in the different Member States, and on Article 235 in view of the lack of any provision explicitly on the environment in the Treaty of Rome. This proposal is being submitted after the entry into force of the Treaty on European Union and places the emphasis on the Community's environmental obligations with regard to impact assessment and, hence, is covered by Article 130s(1).

The environmental assessment procedure not only plays a crucial role in the proper functioning of the internal market; its purpose, above all, is to provide the competent authorities with the information they need to reach an informed decision on any given project. This makes it a basic instrument of environmental policy.

The possibility that the costs of the environmental assessment procedure could create unequal conditions of competition and give rise to market distortions between Member States is only a secondary consideration with regard to the need for this common step, since the cost of the procedure is not such as would sway the investor's choice as to the site of the project.

7. Commentary on the individual articles of the proposal

Article 1 announces the amendments to the following Articles of Directive 85/337/EEC:

**Article 1**

The proposal is to transfer and clarify the definition of "modifications to projects" which appears as a project class in Annex II to the Directive. This operation is felt to be necessary because in practice the interpretation of "modifications to projects" has given rise to problems regarding the scope of the proposed modification (restructuring of a project) and changes to the conditions under which the project has been authorized.

**Article 4**

The aim of the amendments to this Article is to initiate the screening procedure to be applied by the Member States for identifying Annex II projects which require assessment.

**Article 5**

This Article introduces the concept of scoping, the main purpose of which is to facilitate the exchange of information between the various parties concerned and to improve the quality of the assessment.

**Article 6**

It is made clear in paragraph 1 that the environmental authorities must be consulted not only on the developer's application for development consent, but also on the information supplied by the developer.

Similarly, it is made clear in paragraph 2 that the public must be consulted before development consent is granted rather than before the work actually commences. In practice, development consent may be granted a long time before work begins, which in turn may be at a time when the consent can no longer be withdrawn. Consultation of the public would then be pointless.

Article 7

In accordance with the Espoo Convention, this proposal advocates a major improvement in bilateral relations between the Member States as regards consultation of the authorities of any Member State liable to be particularly affected and the latter's participation in the environmental assessment procedure.

The Member States affected by the project must therefore conduct a joint examination of the transboundary effects of the project and the measures to reduce or offset them, all this on the basis of the opinions of the authorities responsible for the environment and their respective nationals. This should ensure closer cooperation between the Member States, in view of the fact that pollution, as is stressed in the fifth environmental action programme[10], does not stop at frontiers.

Article 8

The report highlighted another difficulty in implementing the Directive, namely the extent to which the environmental assessment procedure can exert pro-environmental pressure on the development consent decision.

It would appear that the attention given to the findings of the assessment procedure in terms of preventing or offsetting the effects on the environment is not properly reflected in the decisions taken by the competent authorities.

The requirement that express account be taken of the opinions given by the environment authority and the public concerned should, to some extent, lead to greater transparency in the decisions taken by the competent authority.

Article 9

The main aim of the amendment is to require justification of the decisions taken by the competent authority so that the public may be aware of the effects of the environmental assessment on these decisions.

Article 11

The new wording of Article 4 of Directive 85/337/EEC makes Article 11(2) of that Directive redundant. The latter is therefore deleted.

Article 12

The new wording of Article 2 of the proposal makes Article 12 of the Directive redundant. The latter is therefore deleted.

Article 13

Article 13 is to be deleted, since Article 130t of the Treaty now allows Member States to lay down stricter rules on environmental protection.

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(10) COM(92) 23 final, 12.6.1992.

**Annex I**

Two new categories of project are introduced: installations for the reprocessing of irradiated nuclear fuel, and temporary storage of radioactive waste.

The inclusion of reprocessing installations is justified by the fact that more radioactive waste is produced by this type of installation than by the nuclear power stations already listed in the Annex. Similarly, the temporary storage of waste which presents such a danger to human health must also be assessed prior to authorization.

Lastly, the proposed amendment clarifies the definition of integrated chemical installations.

**Annex II**

The main purpose of the amendments to this Annex is to amalgamate certain categories of project and to tighten up some of the definitions.

It is proposed, for instance, that the agricultural projects category be restructured by transferring the projects for the use of uncultivated land and for the reclamation of land from the sea into a new land use category.

Another new category, "Tourism and leisure", will now encompass the construction of ski-runs and bobsleigh tracks, ski-lifts, golf courses, marinas, camp sites and caravan sites, holiday villages and leisure and cultural centres.

Other amendments cover the infrastructure projects category.

All these amendments are aimed at a clearer definition of the practical scope of the Directive.

**Annex IIa (new Annex)**

The objective of adding this new Annex to Directive 85/337/EEC is to allow application of the new provision in Article 4(3).

This Annex lays down selection criteria to allow Member States to appraise, on an identical basis, whether or not Annex II projects are likely to have a significant impact on the environment.

**Annex III**

Point 2 of the Annex is amended to make the examination of the main alternatives to the project compulsory. This is to make the Directive more effective and to harmonize the relevant national provisions.

**Annex IV**

The objective of this new Annex is to define the procedure for consultation between the Member States and the information considered appropriate in the case of projects with a transboundary impact.

Proposal for a
COUNCIL DIRECTIVE
amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment

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THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 130s(1) thereof,

Having regard to the proposal from the Commission[1],

In cooperation with the European Parliament[2],

Having regard to the opinion of the Economic and Social Committee[3],

Whereas the main purpose of the environmental assessment procedure under Council Directive 85/337/EEC[4] is to provide the competent authorities with relevant information to enable them to make a decision on a specific project in full knowledge of the facts regarding the project's probable impact on the environment; whereas the assessment procedure is therefore a fundamental instrument of environmental policy as defined in Article 130r of the Treaty;

Whereas a sufficient degree of environmental protection must be ensured at Community level by laying down a general assessment framework and criteria for defining those projects which must be submitted for an environmental assessment; whereas, however, in accordance with the subsidiarity principle, the Member States are in the best position to apply those criteria in specific instances;

Whereas the report on the implementation of Directive 85/337/EEC, as adopted by the Commission on 2 April 1993, shows that there are problems in applying the Directive; whereas certain provisions of the Directive should therefore be clarified so that the assessment procedure may produce greater benefits, but without altering the actual scope of the Member States' obligations under the Directive;

Whereas it would, nevertheless, appear necessary to introduce provisions designed to improve the rules on the assessment procedure;

Whereas additions should be made to the list of projects which have significant effects on the environment and which must on that account be made subject to systematic assessment;

Whereas it should also be made clear that such assessment is compulsory for the projects listed in Annex II to the Directive which may have a significant effect on the specific environmental protection objectives laid down by mutual agreement at Community level; whereas in all other cases, however, it falls to the Member States to determine whether assessment is necessary in accordance with the selection criteria set out in this Directive;

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(1) OJ No C

(2) OJ No C

(3) OJ No C

(4) OJ No L 175, 5.7.1985, p. 40.

Whereas some of these measures bring the provisions of the Directive into line with the Convention on environmental impact assessment in a transboundary context (Espoo Convention), which the Community signed at the same time as the Member States on 25 February 1991,

HAS ADOPTED THIS DIRECTIVE:

Article 1

Directive 85/337/EEC is hereby amended as follows:

1. In Article 1(2), the following definition is inserted after the first definition:

"'modifications to projects' means:

any restructuring of a project which affects it substantially or any substantial change in the conditions of execution or operation of a project;".

2. Article 4 is replaced by the following:

"Article 4

1. Subject to Article 2(3), projects listed in Annex I shall be assessed in accordance with Articles 5 to 10.

2. Subject to Article 2(3), projects listed in Annex II shall be assessed in accordance with Articles 5 to 10 where they are liable to have a significant effect on the special protection areas designated by Member States pursuant to Community law.

3. In all other cases, projects listed in Annex II shall be examined by the competent authority to determine, on the basis of thresholds set, where appropriate, by Member States and of the selection criteria laid down in Annex IIa, whether their probable environmental impact necessitates assessment in accordance with Articles 5 to 10.

Member States shall ensure that decisions taken by the competent authority are published."

3. Article 5(1) is replaced by the following:

"1. In the case of projects which, pursuant to Article 4, must undergo environmental impact assessment in accordance with Articles 5 to 10, Member States shall adopt the necessary measures to ensure that the competent authority defines, in agreement with the authorities referred to in Article 6 and in consultation with the developer, the information specified in Annex III which the developer is required to provide, in an appropriate form, in so far as:

(a) the information is relevant to a given stage of the development consent procedure and to the specific characteristics of a particular project or type of project, or those of the environmental features liable to be affected;

(b) a developer may reasonably be required to gather this information having regard, inter alia, to current knowledge and methods of assessment."

4. Article 5(2) is deleted.

5. Article 5(3) is replaced by the following:

"3. Member States shall ensure that any authorities holding relevant information, regard being had in particular to Article 3, shall make this information available to the developer."

6. Article 6(1) is replaced by the following:

"1. Member States shall take the measures necessary to ensure that the authorities likely to be concerned by the project by reason of their specific environmental responsibilities are given an opportunity to express their opinion on the information supplied by the developer and on the request for development consent. To this end, Member States shall designate the authorities to be consulted, either in general terms or on a case-by-case basis, when the request for development consent is made. The information gathered pursuant to Article 5 shall be forwarded to those authorities. Detailed arrangements for consultation shall be laid down by the Member States."

7. In Article 6(2), the words "before the project is initiated" are replaced by the words "before development consent is granted".

8. Article 7 is replaced by the following:

"Article 7

1. Where a Member State considers that a project referred to in Article 4 is liable to have significant adverse effects on the environment of another Member State, or where a Member State whose environment is liable to be significantly affected so requests, the Member State on whose territory the project is located shall communicate to the other Member State, at the latest when it informs its own nationals, the information specified in Annex IV.

2. The Member States concerned shall enter into consultations, setting a reasonable timetable for:

(i) the main alternative solutions to the project which have been examined;

(ii) the measures which may be taken to avoid, reduce and, if possible, offset the adverse transboundary effects;

(iii) possible forms of mutual assistance to lessen any major harmful transboundary impact caused by the proposed project;

(iv) the measures which may be taken to ensure the monitoring of the transboundary effects of the project at the expense of the Member State in which the project is proposed.

3. The authorities of the Member State whose environment is liable to be significantly affected shall hold consultations with the authorities concerned and with the public, in accordance with the provisions of Article 6 and shall, within the time limit provided for in paragraph 2, communicate their opinion on the project to the authorities of the Member State on whose territory the project is located.

However, failure by the authorities of the Member State whose environment is liable to be affected to deliver the opinion mentioned in paragraph 1 within the time limit and in the form specified above, those authorities having been properly informed pursuant to paragraph 2, shall not provide grounds which may be invoked in support of a challenge to the validity of the competent authorities' decision regarding the project."

9. Article 8 is replaced by the following:

"Article 8

The opinions and the information gathered pursuant to Articles 5, 6 and 7 must be taken into consideration in the development consent procedure."

10. Article 9 is replaced by the following:

"Article 9

When a decision has been taken, the competent authority or authorities shall publish it and, where appropriate, inform the other Member State which has been consulted pursuant to Article 7 thereof, indicating:

- the content of the decision and any conditions attached thereto;

- the reasons and considerations on which its decision to refuse to grant development consent, or to grant development consent despite receiving unfavourable opinions pursuant to Articles 6 and 7, is based;

- a description, where necessary, of the measures to avoid, reduce and, if possible, offset the major adverse effects."

11. Article 11(2) is hereby deleted.

12. Article 13 is hereby deleted.

13. The Annexes are amended as shown in the Annex hereto.

Article 2

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 30 June 1996 at the latest. They shall forthwith inform the Commission thereof.

When Member States adopt these provisions, these shall contain a reference to this Directive or shall be accompanied by such reference at the time of their official publication. The procedure for such reference shall be adopted by Member States.

2. If a request for development consent has been submitted to a competent authority before 1 July 1996, the provisions of Directive 85/337/EEC prior to these amendments shall continue to apply.

Article 3

This Directive shall enter into force on the twentieth day following that of its publication in the Official Journal of the European Communities.

Article 4

This Directive is addressed to the Member States.

Done at Brussels,

For the Council
The President

ANNEX

1. Point 3 in Annex I is replaced by the following:

"3. (a) Installations for the reprocessing of irradiated nuclear fuel.

(b) Installations designed solely for the permanent storage or final disposal of radioactive waste and centralized temporary storage installations for radioactive waste or irradiated nuclear fuel."

2. Point 6 in Annex I is replaced by the following:

"6. Integrated chemical installations: installations located in a geographical area in which several units for the industrial production of chemical products, not necessarily belonging to the same company, are juxtaposed and are functionally linked to one another."

3. Point 8 in Annex I is replaced by the following:

"8. (a) Inland waterways which permit the passage of vessels of over 1 350 tonnes;

(b) Trading ports and port installations, including offshore installations, and ports and installations for inland-waterway traffic which permit the passage of vessels of over 1 350 tonnes."

4. Point 1 in Annex II is replaced by the following:

"1. **Agriculture**

(a) Projects for the restructuring of rural land holdings.

(b) Irrigation and land drainage projects.

(c) Afforestation, reafforestation, deforestation.

(d) Intensive stockfarming.

(e) Production of exotic species of flora and fauna.

(f) Intensive fish or shellfish farming."

5. Letter (h) under point 3 in Annex II is deleted.

6. Point 10 in Annex II is replaced by the following:

"10. **Infrastructure projects**

(a) Industrial estate development projects.

(b) Urban development projects, including the construction of shopping centres and car parks.

(c) Doubling, electrification and adjustment to standard gauge of railway lines or tracks for combined transport, construction of railway and intermodal transshipment facilities, and of intermodal terminals.

(d) Construction of airfields and extension of the airport capacity of airfields (projects not listed in Annex I).

(e) Construction and upgrading of roads (widening and alternative routes), harbours and port installations, including fishing harbours (projects not listed in Annex I).

(f) Inland-waterway construction, canalization and flood-relief works.

(g) Dams and other installations designed to hold water or store it on a long-term basis.

(h) Tramways, elevated and underground railways, suspended lines or similar lines of a particular type, used exclusively or mainly for passenger transport.

(i) Oil and gas pipeline installations.

(j) Installation of long-distance aqueducts.

(k) Coastal work to combat erosion and maritime works capable of altering the coast through the construction, for example, of dykes, moles, jetties and other sea defence works."

7. Point 11 in Annex II is replaced by the following:

"11. **Other projects**

(a) Permanent racing and test tracks for cars and motor cycles.

(b) Installations for the disposal of industrial and domestic waste (unless included in Annex I).

(c) Waste-water treatment plants.

(d) Sludge-deposition sites.

(e) Storage of scrap iron.

(f) Test benches for engines, turbines or reactors.

(g) Manufacture of artificial mineral fibres.

(h) Manufacture, packing, loading or placing in cartridges of gunpowder and explosives.

(i) Knackers' yards."

8. The following points are added to Annex II:

"11a **Tourism and leisure**

(a) Ski-runs, bobsleigh tracks and ski-lifts and artificial snow installations.

(b) Golf courses and associated developments.

(c) Marinas.

(d) Holiday villages, hotel complexes and associated developments.

(e) Camp sites and caravan sites

(f) Leisure centres.

11b **Land-use projects**

(a) Changes in the use of uncultivated land, semi-natural areas and natural or semi-natural forests.

(b) Reclamation of land from the sea."

9. Point 12 in Annex II is replaced by the following:

"12. Modifications to projects listed in Annex I or Annex II and projects in Annex I undertaken exclusively or mainly for the development and testing of new methods or products and not used for more than two years."

10. A new Annex IIa is inserted, as follows

"ANNEX IIa

SELECTION CRITERIA REFERRED TO IN ARTICLE 4(3)

1. **Characteristics of the project**

The characteristics of the project must be considered having regard, in particular, to:

- the size of the project[1];
- the use of natural resources;
- the production of waste;
- pollution and nuisances;
- the risk of accidents;
- the impact on the natural and historical heritage having regard to the existing functions of the areas likely to be affected (such as tourism, urban settlement, agriculture).

2. **Location of the project**

The environmental sensitivity of geographical areas likely to be affected by the project must be considered, having regard, in particular, to:

- the relative abundance, quality and regenerative capacity of natural resources in the area;

- the absorption capacity of the natural environment, paying particular attention to the following areas:

(a) wetlands;
(b) coastal zones;
(c) mountain and forest areas;
(d) nature reserves and parks;

---

(1) The size of the project must be considered in relation to the duration, frequency and reversibility of its likely impacts.

(e) areas already classified or protected under Member States' legislation;
(f) areas in which the environmental quality standards laid down in Community legislation have already been exceeded;

(g) densely populated areas;
(h) landscapes of historical, cultural or archaeological significance."

11. Point 2 in Annex III is replaced by the following:

"2. A description of the main alternatives which might be envisaged and an indication of the main reasons for the developer's choice, taking into account the environmental effects."

12. A new Annex IV is added, as follows:

"ANNEX IV

INFORMATION REFERRED TO IN ARTICLE 7

1. A description of the project together with any available information on the possible transboundary impact.

2. Information on the nature of the decision which may be taken.

3. A reasonable time limit within which the other Member State must indicate whether it intends to take part in the assessment procedure. Notification of such intention shall be accompanied by all available relevant information on the environment in that part of the territory which might be affected.

4. The information gathered pursuant to Article 5.

5. An indication of the date on which a decision will be taken on the project and the time limit, calculated on a reasonable basis, within which the Member State likely to be affected must communicate its opinion to the Member State on whose territory the project is located."

IMPACT ASSESSMENT FORM

## THE IMPACT OF THE PROPOSAL ON BUSINESSES

Title of proposal: Amendment of Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment.

**The Proposal**

The proposal does not impose new obligations beyond those already present in the existing Directive 85/337/EEC, but further Community legislation is necessary in this area for the following reasons:

- to remove uncertainties from the existing Directive as revealed by the review of its implementation (COM(93) 28 final);
- to provide for implementation of the Convention on transboundary EIA (Espoo Convention: COM(92) 93 final), which requirements do not go beyond the existing Article 7 of the Directive;
- to improve the effectiveness of the Directive by making more explicit provision for screening Annex II projects for their need for EIA and for scoping and monitoring of the assessment. Since some Member States have adopted these provisions and others have not, both environmental protection and distortion of the market are affected in the absence of legislation at Community level;
- to clarify various terms used in the Directive (for example "integrated chemical installation").

**The impact on businesses**

Who will be affected by the proposal?

Bearing in mind that no new obligations concerning the procedure which is to be applied are imposed by this proposed modification:

- there are three additions to Annex I requiring compulsory assessment which will affect only those businesses engaged in the treatment of spent nuclear fuel and those carrying out projects listed in Annex II, capable of affecting the special protection areas (SPAs) provided for in Community environmental protection legislation;
- in the main, therefore, the additions to Annex I will have impacts only upon a very small number of projects by the large-scale nuclear industry. As regards Annex II projects located in or affecting SPAs, it is impossible to identify whether these will be carried out by large, medium or small-scale businesses.
- the new screening provision will avoid the application of EIA for (mostly small) Annex II projects without likely significant environmental impacts;
- the benefit of the scoping provision will be that the process of producing an environmental impact statement in accordance with the requirements of Annex III to the Directive is likely to be accelerated, since the coverage required by the statement will have been set and agreed upon in advance of its production rather than after it has been submitted to the competent authority. This has been welcomed by, among others, the electricity generating and distribution industry in Europe;

- no particular type of business is affected by the proposed insertion of a requirement to provide details of monitoring of impacts, although it will not really affect certain types of finite project as much as those with a continuing impact on the environment.

What will businesses have to do to comply with the proposal?

In the vast majority of cases, no more than they do currently under the existing Directive on EIA. Except for the obligation to submit certain projects (i.e. spent nuclear fuel reprocessing and those affecting protected zones) to an assessment, there is no great increase in the numbers of EIAs that will be required of businesses in the Member States. The screening process, as well as some of the clarifications to the projects listed in Annex II, will serve to reduce the burdens on certain businesses.

The new requirement concerning scoping of the assessment is expected to speed up the process of information-gathering. Also it will reduce the need for late and expensive additional work to a submitted environmental impact statement, since its scope will have been set in advance.

What economic effects is the proposal likely to have?

On employment:

- since the purpose of EIA is not to prevent development but to provide decision-makers with better information on impacts, mitigatory measures and alternative locations and developments, the impact on employment is likely to be negligible other than in local terms where there may be some relocation of projects as a result of EIA. Also some increase in consultancy work can be expected.

On investment and the creation of businesses:

- given clearer information on the impact of a proposal, both investors and entrepreneurs will be better informed of the risks inherent in a particular project;

On the competitive position of businesses:

- within the Community, assuming correct transposition by all Member States, the effect should be neutral. As regards other countries, the effect will depend upon the regimes operated there since certain countries, e.g. Canada and the USA, have similar if not more advanced systems of EIA (including assessment in certain cases at the higher levels of policy, plan and programme-making). Assessment in the developing countries is usually less well-developed.

Does the proposal contain measures to take account of the specific situation of small and medium-sized firms (reduced or different requirements etc.)?

Under the terms of the new Article 4 it is the competence of Member States to determine, on the basis of specified criteria, whether their probable impact gives rise to the need for assessment. This gives Member States the opportunity to specify levels of activity which would exclude small or medium-sized enterprises being required to carry out an EIA for projects normally contemplated by such size of businesses. It is unlikely that SMEs would be carrying out an Annex I project.

**Consultation**

Outside the Commission the **Member States Experts Working Group** has considered the proposal at three meetings and has amended it in a number of significant respects as a result (for example, by the removal of a number of projects introduced into Annex I).

Also comments made by UNICE have resulted in other amendments to the proposal, in particular concerning the definition of integrated chemical installations.

Within the Commission it was anticipated that other DGs might be in the position to bring into the discussion the major considerations to be expected in their respective policy sectors.

However, consultations with the Economic and Social Committee under Article 198 of the Treaty will guarantee a wide-ranging debate with the socio-economic groups involved.

## Appendix A - EA Contacts in the NRA

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| **Anglian** | | | |
| Northern Area | Area Planning Manager<br>NRA Anglian<br>Aqua House<br>Harvey Street<br>LINCOLN LN1 1TF | 01522 513100 | 01522 512927 |
| Central Area | Area Planning Manager<br>NRA Anglian<br>Bromholme Lane<br>Brampton<br>Huntingdon<br>CAMBS PE18 8NE | 01480 414581 | 01480 413381 |
| Eastern Area | Area Planning Manager<br>NRA Anglian<br>Cobham Road<br>IPSWICH IP3 PJE | 01473 727712 | 01473 724205 |
| **Northumbria & Yorkshire** | | | |
| Northumbria Area | Planning Liaison Officer<br>NRA Northumbria & Yorkshire<br>Tyneside House<br>Skinnerburn<br>Newcastle Business Park<br>NEWCASTLE UPON TYNE<br>NE4 7AR | 0191 2034000 | 0191 2034004 |
| Dales Area | Planning Liaison Officer<br>NRA Northumbria & Yorkshire<br>Coverdale House<br>Aviator Court<br>Amy Johnson Way<br>Clifton Moor<br>YORK | 01904 692296 | 01904 693748 |
| Southern Yorkshire | Planning Liaison Officer<br>NRA Northumbria & Yorkshire<br>Olympia House<br>Gelderd Lane<br>Gelderd Road<br>LEEDS LS12 6DD | 01132 440191 | 01132 312116 |
| **North West** | | | |
| Northern Area | Planning and Services Manager<br>NRA North West<br>Chertsey Hill<br>London Road<br>CARLISLE CA1 2QX | 01228 25151 | 01228 49734 |
| Central Area | Planning and Services Manager<br>NRA North West<br>Lutra House<br>Dodd Way<br>Walton Summitt<br>Bamber Bridge<br>PRESTON PR5 8BX | 01772 39882 | 01772 627730 |

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| Southern Area | Planning and Services Manager<br>NRA North West<br>Mirwell<br>Carrington Lane<br>SALE M33 5NL | 0161 973 2237 | 0161 973 4601 |
| **Severn-Trent** | | | |
| Upper Severn Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Hafren House<br>Welshpool Road<br>Shelton<br>SHREWSBURY SY3 8BB | 01217 112324 | 01217 115824 |
| Lower Severn Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Riversmeet House<br>Northway Lane<br>TEWSKESBURY GL20 8JG | 01684 850951 | 01684 293599 |
| Upper Severn Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Sentinel House<br>9 Wellington Crescent<br>Fradley Park<br>Lichfield<br>STAFFS SW13 8RR | 01543 444141 | 01543 444161 |
| Lower Trent Area | Senior Planning Liaison Officer<br>NRA Severn-Trent<br>Trentside Office<br>Scarrington Road<br>West Bridgford<br>NOTTINGHAM NG2 5FA | 01159 455722 | 01159 817743 |
| **Southern** | | | |
| Hampshire & Isle of Wight | Planning Liaison Manager<br>NRA Southern<br>Sarum Court<br>Sarum Road<br>WINCHESTER<br>HANTS SO22 5DP | 01962 713267 | 01962 841573 |
| Kent Area | Planning Liaison Manager<br>NRA Southern<br>Millbrook House<br>114 Mill Street<br>East Malling, Maidstone<br>KENT ME19 6BU | 01732 875587 | 01732 875057 |
| Sussex Area | Planning Liaison Manager<br>NRA Southern<br>3 Liverpool Gardens<br>Worthing<br>WEST SUSSEX BN11 1TF | 01903 215835 | 01903 215884 |

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| **South Western** | | | |
| Cornwall Area | Regulation Officer<br>NRA South Western<br>Sir John Moore House<br>Victoria Square<br>Bodmin<br>CORNWALL PL31 1EB | 01208 78301 | 01208 78825 |
| Devon Area | Regulation Officer<br>NRA South Western<br>Manley House<br>Kestrel Way<br>EXETER EX2 7LQ | 01392 444000 | 01392 444238 |
| North Wessex Area | Regulation Officer<br>NRA South Western<br>Rivers House<br>East Quay<br>SOMERSET TA6 4US | 01278 457333 | 01278 452985 |
| South Wessex Area | Regulation Officer<br>NRA South Western<br>Rivers House<br>Sunrise Business Park<br>High Shaftesbury Road<br>BLANDFORD DT11 8ST | 01258 456080 | 01258 455998 |
| **Thames** | | | |
| North East | Senior Planning Liaison Officer<br>NRA Thames<br>Gade House<br>London Road<br>Rickmansworth<br>HERTS WD3 1RS | 01992 635566 | 01992 645451 |
| South East | Senior Planning Liaison Officer<br>NRA Thames<br>Sunbury Yard<br>Riverside Works<br>Fordbridge Road<br>Sunbury on Thames<br>TW16 6AP | 01932 789833 | 01932 786463 |
| West Area | Senior Planning Liaison Officer<br>NRA Thames<br>Isis House<br>Howberry Park<br>Wallingford<br>OXON OX10 8BD | 01734 535000 | 01734 535900 |
| **Welsh** | | | |
| Northern | Development Liaison Officer<br>NRA Welsh<br>Bryn Menai<br>Holyhead Road<br>Bangor<br>GWYNEDD LL57 2EF | 01248 370970 | 01248 370747 |

| Region/Area | Contact Address | Tel. No. | Fax No. |
|---|---|---|---|
| South Eastern Area | Development Liaison Officer<br>NRA Welsh<br>c/o Rivers House<br>St Mellons Business Park<br>St Mellons<br>CARDIFF CF3 0LT | 01222 770088 | 0122 798555 |
| South Western Area | Development Liaison Officer<br>NRA Welsh<br>Lus Afon<br>Hawthorn Rise<br>Haverfordwest<br>DYFED SA61 2BH | 01437 760081 | 01437 760881 |

## Appendix B Review Criteria

**Recommended criteria for the review of environmental information or environmental statements provided by developers in association with planning application, licence applications etc.**

The following review criteria may usefully be applied to Environmental Statements (ESs) and may also be applicable to environmental information supplied in connection with larger, more significant schemes that do not warrant formal EA. The criteria should be applied primarily by planning liaison (or equivalent) staff, although support may also be required from technical specialists for some areas (see 'Reviewers'). Such support may best be sought at the same time as the EA or relevant sections is/are circulated for comment. The criteria are arranged into nine main sections:

1. General ES content - overview
2. The EA process - consultation
3. The description of the proposed project
4. Alternatives
5. Site and local environment
6. Predicted environmental impacts
7. Mitigation and enhancements
8. Monitoring and maintenance
9. Presentation and non-technical summary

### Relevance

Each section is then divided into questions indicating tasks or issues which may or may not be relevant. Responses under the 'Relevant' column should indicate whether the issue is (Y) or is not applicable (N). Note that for environmental information that is not in the form of an ES, a large number of the attributes or questions may not be applicable. Also, the 'not applicable' response should only be used where the subject is genuinely not applicable and should not be used as a 'not sure' option.

### Adequacy of information

For each relevant criterion, the reviewer should express a judgment of C, A or I based on the following:

Complete - The information presented is complete in consideration of the issues in question.

Acceptable - The information presented is not complete, but omissions are generally minor.

Inadequate - The information presented contains major omissions; additional information is required before the NRA can fully assess the proposal.

Where category boundaries lie will be a matter for judgment. Comments may be added to support any judgments made.

## Summation of grades

Based on the judgments made within each of the nine sections, on completion of each section the reviewer should then grade each section from A-E indicating how well the tasks have been performed where:

A - Excellent, all tasks performed well
B - Good, no important omissions or inadequacies
C - Satisfactory, despite some omissions and inadequacies
D - Inadequate, some important omissions, but parts well attempted
E - Poor, important omissions and inadequacies
N/A - The category is not applicable for the project

Again, where category boundaries lie will be a matter for judgment. The grades attributed to each of the nine sections may be complied in the table at the end and a single grade attributed to the whole report. No detailed weightings are recommended, but it is suggested that a reduced weighting be given to Section 1, as it is repeated elsewhere in more detail, and Section 9 as the presentation of the ES is not critical to the protection of the environment. Section 6 should be given added weighting due to its length, although it should be borne in mind that some of the features in 6.1, e.g. air, are not of direct interest to the NRA. Whilst a grade of C is satisfactory, a good ES should score A or B.

## Reviewers

Ideally and where resources allow, more than one person (generally from planning liaison) would review an ES as a whole, in order to reduce the subjectivity of an individual reviewer. Upon circulating the ES for comment, specialists may be asked to provide judgments on specific criteria relevant to the responsibilities/background of the reviewer. As a guide specialists may be particularly required in the following areas:

| Technical Area/Function | Relevant Criteria |
|---|---|
| Fisheries | 5.10, 6.2 (h)-(j) |
| Recreation | 5.11, 6.2 (j), (l)-(p) |
| Conservation | 5.7, 5.9, 5.11, 5.17, 5.18, 6.2 (a)-(g), (k), (s), (x) |
| Navigation | 6.2 (p) |
| Water quality | 5.7, 5.15, 5.16 (y), (z) |
| Water resources | 5.12, 5.14, 5.16, 6.2 (t)-(w), (z) |
| Flood defence | 5.12, 5.13, 5.18, 6.2 (q)-(t) |

Reviewers should bear in mind that the adequacy of the extent of coverage of an issue and the opportunities of methods, of data collection and treatment will vary according to the size and complexity of the development scheme involved.

# THE REVIEW CRITERIA

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 1. | **General ES content - overview** | | | |
| 1.1 | To what extent does the ES contain a clear description of the full extent of:<br>a) the development?<br>b) associated activities? | | | |
| 1.2 | To what extent does the ES discuss alternatives of either process or location? | | | |
| 1.3 | To what extent does the ES contain full and detailed information on the site and local environment with information on:<br>a) site location?<br>b) land use, ecological interest etc? | | | |
| 1.4 | To what extent are potential impacts thoroughly discussed and examined? | | | |
| 1.5 | To what extent is a variety of mitigation and enhancement options considered? | | | |
| 1.6 | To what extent is an appropriate monitoring and maintenance strategy proposed? | | | |

Does the ES clearly explain who has been consulted and at what time? Score [ ] A-E

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| **2.** | **The EA Process - consultations etc** | | | |
| 2.1 | To what extent is there a full list of who has been consulted? | | | |
| 2.2 | To what extent was the NRA consulted at an early stage? | | | |
| 2.3 | To what extent was the public consulted at an early stage? | | | |
| 2.4 | To what extent is there a summary of responses, highlighting areas of concern? | | | |
| 2.5 | To what extent was the consultation process continuous throughout the project life? | | | |
| 2.6 | To what extent have the concerns of the NRA raised in consultation been taken into account? | | | |

Does the ES clearly explain who has been consulted and at what time? Score [ ] A-E

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| **3.** | **The description of the proposed project** | | | |
| 3.1 | To what extent is the design, size and scale of the project (in construction) shown? | | | |
| 3.2 | To what extent is the timing and phasing of construction activities shown? | | | |
| 3.3 | To what extent is the design, size and scale of the project (in operation) shown? | | | |
| 3.4 | To what extent are the water supply and/or abstraction requirements, if any, of the project indicated? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 3.5 | To what extent are the type and quantity of any materials used during construction and operation described? | | | |
| 3.6 | To what extent are the type and quantity of any residues, emissions or other waste described? | | | |
| 3.7 | In particular, to what extent is the volume, frequency and quality of discharges to surface and ground waters described? | | | |
| 3.8 | To what extent are the strategic implications of the project indicated:<br>a) on a local scale?<br>b) on a regional/national scale? | | | |
| 3.9 | To what extent are strategies for operation and decommissioning included? | | | |

How adequate is the description of the proposed project? Score [ ] A-E

**4. Alternatives**

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 4.1 | To what extent are alternative designs or developments considered? | | | |
| 4.2 | To what extent are alternative locations considered? | | | |
| 4.3 | To what extent is the "do nothing" approach considered? | | | |
| 4.4 | To what extent is there consideration of a more environmentally sensitive alternative to the project than that proposed? | | | |
| 4.5 | To what extent are valid reasons given for its rejection in favour of the proposed project? | | | |

Are the main alternatives to the project identified and is their rejection justified? Score [ ] A-E

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| **5.** | **Site and local environment** | | | |
| 5.1 | To what extent are maps of the area directly affected included? (including associated access roads, compounds etc.) | | | |
| 5.2 | To what extent is the area more broadly affected indicated? (e.g. downstream areas, wetlands etc.) | | | |
| 5.3 | To what extent is there an outline of land use, e.g. recreation? | | | |
| 5.4 | To what extent is reference made to the relevant site designations, sensitive areas, local plans, EC Directives and other legislative requirements? | | | |
| 5.5 | To what extent is use made of photographic and other illustrative material? | | | |
| 5.6 | To what extent are any physical characteristics quantified? | | | |
| 5.7 | To what extent is information on aquatic ecology supplied?<br><br>And with relevant:<br>a) methods of data collection?<br>b) survey and sampling techniques?<br>c) the timing if the baseline data collection? | | | |
| 5.8 | To what extent are rare and/or protected species highlighted? | | | |
| 5.9 | To what extent is information on habitats presented for:<br>a) adjacent land (to watercourses) and wetlands?<br>b) bank?<br>c) foreshore?<br>d) channel and water? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 5.10 | To what extent is information on fisheries supplied?<br><br>And with relevant:<br>a) methods of data collection?<br>b) survey and sampling techniques?<br>c) the timing of the baseline data collection? | | | |
| 5.11 | To what extent is information on recreation, amenity and landscape supplied?<br><br>And with relevant:<br>a) methods of data collection?<br>b) survey and sampling techniques?<br>c) the timing of the baseline data collection? | | | |
| 5.12 | To what extent is information on hydrology supplied?<br><br>And with relevant:<br>a) methods of data collection?<br>b) survey and sampling techniques?<br>c) the timing of the baseline data collection? | | | |
| 5.13 | To what extent is information on flood defence supplied?<br><br>And with relevant methods of data collection and survey techniques? | | | |
| 5.14 | To what extent is information on water resources supplied?<br><br>And with relevant methods of data collection and survey techniques? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 5.15 | To what extent is information on surface water quality supplied?<br><br>And with relevant:<br>a) methods of data collection?<br>b) survey and sampling techniques?<br>c) the timing of the baseline data collection? | | | |
| 5.16 | To what extent is information on groundwater quality supplied?<br><br>And with relevant:<br>a) methods of data collection?<br>b) survey and sampling techniques?<br>c) the timing of the baseline data collection? | | | |
| 5.17 | To what extent is information on technology supplied?<br><br>And with relevant methods of data collection and survey techniques? | | | |
| 5.18 | To what extent is information on river geomorphology supplied?<br><br>And with relevant methods of data collection and survey techniques? | | | |
| 5.19 | To what extent have data known to be supplied by the NRA been usefully incorporated? | | | |

How adequate is the description of the site and local environment? Score [ ] A-E

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| **6.** | **Predicted environmental impacts** | | | |
| 6.1 | To what extent are impacts on the following generally considered:<br>a) human beings?<br>b) flora?<br>c) soil?<br>d) water?<br>e) air?<br>f) climate?<br>g) the landscape?<br>h) the interaction between any of the foregoing?<br>i) material assets?<br>j) the cultural heritage? | | | |
| 6.2 | To what extent are impacts suitable assessed for:<br>a) aquatic mammals?<br>b) aquatic birds?<br>c) aquatic amphibians?<br>d) aquatic invertebrates?<br>e) aquatic flora (bankside)?<br>f) aquatic flora (instream)?<br>g) aquatic and riparian habitats?<br>h) aquatic fish and fish habitat?<br>i) commercial fisheries?<br>j) recreational fisheries?<br>k) rare or valued flora and fauna as identified?<br>l) recreational use for water sports?<br>m) recreational use by bird watchers and ramblers?<br>n) access?<br>o) visual intrusion and landscape?<br>p) navigation?<br>q) flood defence and drainage of site of development?<br>r) flood risk to other sites (e.g. downstream)?<br>s) river geomorphology? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| | t) surface water hydrology?<br>u) groundwater hydrology?<br>v) (surface) water resources?<br>w) (ground) water resources?<br>x) archaeology?<br>y) surface water quality:<br>from discharges in construction?<br>from discharges in operation?<br>from surface runoff in construction?<br>from surface runoff in operation?<br>z) ground water quality? | | | |
| 6.3 | To what extent has the assessment addressed impacts likely to affect NRA interests? | | | |
| 6.4 | To what extent has the assessment addressed any other important impacts? | | | |
| 6.5 | To what extent does the ES highlight the key impacts? | | | |
| 6.6 | To what extent are construction impacts indicated as well as those associated with the operation of the project? | | | |
| 6.7 | To what extent are the potential impacts of non-standard operating conditions considered? For example, those arising from equipment failure, flooding etc. | | | |
| 6.8 | To what extent are the effect of decommissioning the project considered? | | | |
| 6.9 | To what extent does the ES indicate if the impacts are:<br>- strategic or local?<br>- temporary or permanent?<br>- short or long term?<br>- adverse or beneficial?<br>- direct or indirect? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 6.10 | To what extent are impacts quantified where possible and an indication of their magnitude and significance given? | | | |
| 6.11 | To what extent are the models used for impact prediction suitable? | | | |
| 6.12 | To what extent are quantitative predictions accompanied by associated levels of uncertainty? | | | |
| 6.13 | To what extent does the ES indicate if the proposal and associated schemes are part of a sustainable development strategy? | | | |

Are both general impacts and those specifically affecting NRA interests identified, evaluated and clearly presented? Score [ ] A-E

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 7. | Mitigation and enhancements | | | |
| 7.1 | To what extent have reasonable mitigation measures been proposed? | | | |
| 7.2 | To what extent does the ES indicate how the mitigation is to be implemented? | | | |
| 7.3 | To what extent is the likely success of mitigation measures indicated? | | | |
| 7.4 | To what extent are the proposed mitigation methods acceptable? | | | |
| 7.5 | To what extent does the ES clearly identify any residual impacts, which cannot be mitigated against? | | | |
| 7.6 | To what extent has the opportunity been taken to incorporate enhancements appropriate to the local environment? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 7.7 | To what extent are 'enhancements' in keeping with the local environment? | | | |

Are all significant adverse impacts mitigated to the NRA's satisfaction and is the opportunity taken to incorporate appropriate enhancements? Score [ ] A-E

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| **8.** | **Monitoring and maintenance** | | | |
| 8.1 | To what extent are there adequate provisions for monitoring impacts during:<br>- construction?<br>- operation? | | | |
| 8.2 | To what extent is there a suitable plan for:<br>- maintenance?<br>- restoration and aftercare?<br>- disposal of wastes? | | | |
| 8.3 | To what extent is there a suitable strategy to deal with emergencies, such as spillages or accidents? | | | |
| 8.4 | To what extent is there a suitable strategy to deal with unexpected impacts? (e.g those detected by monitoring). | | | |
| **9.** | **Presentation and non-technical summary** | | | |
| 9.1 | To what extent does the ES have:<br>- a list of contents?<br>- a glossary?<br>- a reference list?<br>- non-technical summary? | | | |
| 9.2 | To what extent does the non-technical summary present the main findings? | | | |

| No. | Criterion | Relevant? (Y/N) | Judgment (C/A/I) | Comments |
|---|---|---|---|---|
| 9.3 | To what extent is the ES presented as an integrated whole? | | | |
| 9.4 | To what extent is the language clear and concise? | | | |
| 9.5 | To what extent has the assessment been carried out in a logical and rational manner? | | | |
| 9.6 | To what extent are quantifications supported by an indication of the level of confidence? | | | |
| 9.7 | To what extent are survey or predictive techniques explained? | | | |
| 9.8 | To what extent does the ES indicate why these methods or techniques have been used? | | | |
| 9.9 | To what extent are difficulties in compiling information for the ES indicated? | | | |
| 9.10 | To what extent are adverse impacts outlined without bias? | | | |
| 9.11 | To what extent are claims made in the ES substantiated? | | | |

## SUMMARY AND OVERALL APPRAISAL

| No. | Criterion | Relevant? (Y/N) | Grade (A-E) | Comments |
|---|---|---|---|---|
| 1. | General ES content - overview | | | |
| 2. | The EA process - consultation | | | |
| 3. | The description of the proposed project | | | |
| 4. | Alternatives | | | |
| 5. | Site and local environment | | | |
| 6. | Predicted environmental impacts | | | |
| 7. | Mitigation and enhancements | | | |
| 8. | Monitoring and maintenance | | | |
| 9. | Presentation and non-technical summary | | | |

OVERALL ASSESSMENT (A-E) Excellent/Good/Satisfactory/Inadequate/Poor

## Notification of ES Quality

A sheet similar to this should be sent to the developer, those involved in the production of the Environmental Statement (ES) and the local planning authority to inform them of the quality of an ES. Such notifications should contribute to the quality of future ESs. A further copy should be retained with the ES as a permanent NRA record. The sheet may also be appropriate for environmental information, where it covers a variety of subject areas.

ENVIRONMENTAL QUALITY STATEMENT

..........................Region of the National Rivers Authority (NRA) has a policy of issuing a brief report on the quality of Environmental Statements received. The aim of this is to help developers produce more satisfactory Statements in the future or to know that the standard that they have achieved is adequate. The opinion given is entirely independent of the project itself.

The Environmental Statement accompanying Planning Application ................................ was determined, after thorough review, to be:

Excellent, all tasks performed well
Good, no important omissions or inadequacies
Satisfactory, despite some omissions and inadequacies
Inadequate, some important omissions, but parts well attempted
Poor, important omissions and inadequacies

The following aspects were considered to be well executed:

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The following aspects were considered to be poorly executed and important information was lacking:

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It was noted that consultation did/did not take place with the NRA prior to submission of the Statement.

Statement reviewed by:

## Appendix C Supporting Information

### Letter to accompany guidance notes issued to developers and their contractors.

Dear ......

The guidance enclosed has been produced to provide developers and/or their consultants on the general concerns of the National Rivers Authority (NRA) about issues for which they have responsibility that may be affected by developments of the type proposed. The guidance is not intended to replace consultation with specialists from the NRA and/or other organizations, and both general and detailed advice should still be sought. Nor is the guidance intended to cover all the environmental issues that should be addressed in an Environmental Impact Assessment or other environmental studies. For instance, factors such as the traffic flow implications of a development are not considered in the guidance (despite their importance), as these are not within the remit of the NRA. The notes concentrate on those issues within the NRA's statutory responsibilities that may commonly arise in connection with certain types of development. The notes also concentrate on the likely direct impacts of specific development types; indirect impacts will also need to be considered.

It is intended that these notes be used to assist in the scoping of environmental studies carried out to in connection with development proposals. Scoping may be defined as a procedure for determining the extent of, and approach to, the assessment of environmental impacts. The NRA welcomes early consultation with developers on proposed schemes and encourages the production of a free-standing scoping report, which typically identifies feasible alternatives, key impacts and mitigation measures, potential significance of impacts and nature and coverage of environmental assessment. Early consultation between developers (or their consultants) and environmental organizations such as the NRA has been found to generally lead to better designed projects with savings in terms of time and cost to all parties concerned.

The guidance attached is necessarily of a general advisory nature and should be used without prejudice when being used to consider individual development proposals. More detailed, and possibly alternative, recommendations may arise in discussions or negotiations with the NRA on specific proposals. These notes complement any less detailed scoping guidance that may also have been provided at an earlier stage.

The general format of the guidance includes brief information on the need for environmental assessment, expected impacts in construction and operational stages (where appropriate), likely mitigation measures, and suggestions as to the kinds of surveys that may be required. Also included is information on authorizations likely to be required by the development for which the NRA is the licensing body. Please note that prosecution may result from general pollution, from unlicensed activities, or from breaches of the conditions of authorizations, such as excedance of discharge consent limits. Applications for consent or licences may be refused by the NRA.

Please also note that the term Environmental Assessment or EA is used in the guidance in preference to Environmental Impact Assessment.

Yours ......

Enc.

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The following references may have general application in the context of EA.

Construction Industry Research and Information Association (1992) *Scope for the control of urban runoff.* Report R123/124. CIRIA, London.

Construction Industry Research and Information Association (1994) *Environmental Assessment.* Special Publication 96. CIRIA, London.

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Department of the Environment (1994) *Evaluation of environmental information for planning projects - a good practice guide.* HMSO, London.

Department of the Environment/Welsh Office (1989) *Environmental assessment: a guide to the Procedures.* HMSO, London.

Department of the Environment/Welsh Office (1992) *Planning Policy Guidance: Coastal Planning*. PPG20. HMSO, London.

Department of the Environment/Welsh Office (1993) *Development Below Low Water Mark.* HMSO, London.

Department of the Environment/Welsh Office (1991) *Integrated Pollution Control: A practical guide*. HMSO, London.

Department of the Environment/Welsh Office (1993) *Planning Policy Guidance: Renewable Energy*. PPG 22. HMSO, London.

Department of Trade and Industry (1992) *Guidelines for the Environmental Assessment of Cross-Country Pipelines.* HMSO, London.

Department of Transport (1992) *Transport and Works Act 1992: A Guide to Procedures for obtaining orders relating to transport systems, inland waterways and works interfering with rights of navigation.* HMSO, London.

Department of Transport (1993) *Design Manual for Roads and Bridges. Volume 11 Environmental Assessment.* HMSO, London.

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Highways Agency (1994) MCD special requirements for the National Rivers Authority and revised MCD Clause 29. Guidance Note 27.

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Institute of Environmental Assessment (1995) *Guidelines for landscape and visual impact assessment.* IEA, Lincoln.

Institute of Environmental Assessment (1995) *Guidelines for baseline ecological assessment.* IEA, Lincoln.

Luker, M. and Montague, K. (1994) *Control of pollution from highway drainage discharges.* CIRIA Report 142. Construction Industry Research and Information Association, London.

Ministry of Agriculture, Fisheries and Food (1985) *Guidelines for the use of herbicides on weeds in or near to watercourses and lakes*. MAFF. (NB these guidelines are currently being updated).

Ministry of Agriculture, Fisheries and Food (1991) *A code of good agricultural practice for the protection of water*. MAFF, London.

National Rivers Authority (1992) *Policy and practice for the protection of groundwater.* HMSO, London.

National Rivers Authority (1992) *River corridor surveys: methods and procedures.* Conservation Technical Handbook N° 1. NRA, Bristol.

National Rivers Authority (1993) *Design and operation of trash screens - interim guidance notes.* Pamphlet P-126. NRA, Bristol.

National Rivers Authority (1993) *River landscape assessment: methods and procedures.* Conservation Technical Handbook N° 2. NRA, Bristol.

National Rivers Authority (1994) *Contaminated land and the water environment.* Water Quality Series N°15. HMSO, London.

National Rivers Authority (1994) *Guidance for the control of invasive plants near watercourses.* NRA, Bristol.

National Rivers Authority (1994) *Abandoned mines and the water environment.* Water Quality Series N°14. HMSO, London.

National Rivers Authority (1994) *Guidance notes for Local Planning Authorities on the methods of protecting the water environment through development plans.* NRA, Bristol.

National Rivers Authority (1994) *Abstraction Licensing and Water Resources.* NRA, Bristol.

National Rivers Authority (1994) *National Guidelines on redevelopment of contaminated land.* NRA, Bristol.

National Rivers Authority (1994) *Water: nature's precious resource. An environmentally sustainable water resources development strategy for England and Wales.* HMSO, London.

National Rivers Authority (1994) *Discharges Consents and Compliance - the NRA's approach to control of discharges to water.* Water Quality Series No. 17. HMSO, London.

National Rivers Authority (1995) *Landfill and the Water Environment.* NRA Position Statement. NRA, Bristol.

National Rivers Authority (1995) *Discharge Consents Manual.* NRA, Bristol.

National Rivers Authority (1995) *Licensing Manual (Water Resources).* NRA, Bristol.

National Rivers Authority (1995) *The use of herbicides in or near water.* NRA (Anglian Region), Peterborough.

National Rivers Authority (various dates) Various Pollution Prevention Guidelines.

Naylor, J.A., Rowland, C.D. Young, C.P. and Barber, C. (1978) *The investigation of landfill sites.* WRc Technical Report TR91.

Petts, J. and Edujee, G. (1994) *Environmental Impact Assessment for Waste Treatment and Disposal Facilities.* Wiley, Chichester.

Solomon, D.J. (1992) *Diversion and Entrapment of Fish at Water Intakes and Outfalls. NRA R&D Report 1.* HMSO, London.

## Appendix D - Further information for use by the NRA internally

Additional information is provided and arranged in order of development type

### 1. General Construction

The *Discharge Consents Manual* and *Licensing Manual (Water Resources)* may be essential sources of reference. The Procedural Manual *Development in sewered areas* (SC/EQ/008 - in draft, January 1995) may also be useful.

Various PINs and other internal guidance may be relevant. It may be appropriate to issue Standard Conditions and various Pollution Prevention Guidelines (see Appendix 3).

The Waste Disposal/Contaminated Land Group are currently preparing relevant guidance that may be relevant.

A document *Ground investigations for the assessment of existing or proposed developments which may impact on the protection of groundwaters* is currently in draft. When finalized/published this should be passed onto developers as appropriate.

Outputs from CIRIA research project RP 448 *Manual on infiltration methods for stormwater source control* may be relevant when available.

It is important that the correct constraints and conditions are written in at the outset from noise levels, working hours etc. to physical definition of site and fencing which is permanent and secure enough to maintain controls.

Staff should bear possible impacts on archaeological interests in mind. Research has shown that whilst the NRA pursued its duty to conserve wildlife and landscape with vigour, less emphasis appears to be given to archaeology (Evans and Hill 1994).[1]

Various guidance/external standards exist that may be relevant, such as:

- with respect to earthworks - control of drainage should comply with British Standard Code of Practice for Earthworks BS 6031:1981;
- with respect to foundations - British Standard Code of Practice for Foundations BS 304:1986; and
- Department of Trade Specifications for Highway Works (1986)

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1 Evans, G. and Hill, R. (1994) *The NRA and archaeology.* R&D Note 289, National Rivers Authority, Bristol.

## 2. Reservoirs

The *Licensing Manual (Water Resources)* may be a useful source of reference.

There are separate scoping guidance on Off Line Ponds and Reservoirs.

The PIN on impounding licences TE/WR/014 may be relevant.

## 3. Marinas

Guidance on navigation issues may also be relevant to developers and the NRA.

NRA Pollution Prevention Guidelines 14 *Inland waterways: marinas and craft* will generally be relevant and should be issued to appropriate parties. NRA PPGs 2, 5, 6, 8, 9 and 13 may also be relevant.

The Discharge Consents Manual may be a useful source of reference.

Planning issues with regard to developments in coastal areas are discussed in both *Development Below Low Water Mark* (DoE/WO 1993) and Planning Policy Guidance PPG20 *Coastal Planning* (DoE/WO 1992). The former suggests that legislation may be considered to clarify the treatment in planning of construction projects, such as marinas, that straddle the boundary of the land use planning system.

## 4. Barrages

Welsh Region have produced more detailed guidance that should be used by NRA staff and made available to developers/promoters during negotiations (contact Dr. Andrew Rees).

A number of controversial barrages schemes have arisen with the Welsh Region as reported by Jones (1994). This paper refers to the experience gained from negotiations on the Tawe, Cardiff Bay and River Usk Barrages, together with position statements. For the Cardiff Bay Barrage the NRA secured "Powers of Direction", whereby the developer "can be directed to take any action necessary to remedy the damage" if there proves to be an unacceptable environmental impact.

A series of barrage developments may have a cumulative effect. For example, the construction of barrages upon the few remaining creeks in the London area would mean that there would be no tidal creek habitat remaining in the Upper Thames Estuary with a corresponding reduction of the faunal diversity of the area.

The NRA is a consultee for licences required (from MAFF) under the Food and Environmental Protection Act (FEPA) and licence applications (from MAFF/Welsh Office) for dredging marine aggregates.

NRA staff dealing with barrage proposals should be aware that reliable methods do not exist to predict the impact of barrages on flow patterns, sedimentation, water chemistry, biology, bacteria and viruses, fisheries etc. The existing ecosystem models are based on the outputs of physical and chemical models and, therefore, uncertainties are amplified. In summary, a properly scoped and executed EA will still not give a reliable prediction of the impact of a barrage.

As a result of the highly variable nature of environments, such as estuaries, it should also be made clear to promoters that a long-term baseline study will be required, in order to isolate impacts of the barrage from wide natural variations.

The PIN on impounding licences TE/WR/014 may be relevant. The Discharge Consents Manual may also be a useful source of reference.

## 5. Fish farms

Requirements for environmental protection are set out in the fish farming sections of the NRA Consents and Licensing Manuals. TE/WR/010 *Flow monitoring and recording for fish farms* and TE/FH/006 *Section 30 and disease procedures* may also be relevant.

Fish farms may start on a small scale and subsequently expand rapidly causing significant effects. Consideration of potential expansion should be made when reviewing proposals. Similarly, several small farms in a localized area may have a significant cumulative impact. NRA experience suggests it may be difficult to obtain reliable estimates of planned annual production.

The NRA have commissioned research on crayfish (Holdich *et al.* at Nottingham University) which will provide data on the distribution of native and non-native species and recommended farming methods to limit the spread off non-native species.

Other sources of information include the following.

House of Commons Agriculture Committee (1990) *Fish Farming in the UK*. Volume 1: Report and Proceedings of the Committee. HMSO, London.

Institute of Aquaculture (1990) *Fish Farming and the Scottish Freshwater Environment*. Nature Conservancy Council, Edinburgh.

Mainstone, C., Lambton, S., Gulson, J. and Seager, J. (1989) The Environmental Impact of Fish Farming - Review. P-4, National Rivers Authority, Bristol.

## 6. Pipelines

The Discharge Consents Manual may be a useful source of reference.

The following Pollution Prevention Guidelines may be particularly relevant:

2 Above ground oil storage tanks
3 The use and design of oil separators in surface water drainage systems
4 Disposal of sewage where no mains drainage is available
5 Works in, near or liable to affect watercourses
6 Working at demolition and construction sites
8 Safe storage and disposal of used oils
9 The prevention of pollution of controlled waters by pesticides
13 Guidance note on the use of high pressure water and steam cleaners.

Pipeline construction is a particularly significant development due the long lengths over which a site is active, resulting in vast areas of exposed soil and subsoil and devastating silty discharges. Ideally, discharge points, methods of treatment and consent conditions should be agreed well in advance.

## 7. Long sea outfalls

The Discharge Consents Manual, including the AMP2 guidelines, will be an essential source of reference. Guidance on UWWT Directive implementation and the draft disinfection policy may also be relevant.

NRA SW Tidal Waters Quality Group have produced (1994) Technical paper on guidelines for the development and assessment of impacts of WS plc schemes for the collection, treatment and disposal of sewage to tidal waters.

## 8. Points of large abstraction

The *Licensing Manual (Water Resources)* is an essential source of reference.

The document *Water - Nature's Precious Resource. An environmentally sustainable water resources development strategy for England and Wales* (NRA 1994) provides information on areas of England and Wales expected to have shortfalls in supply and also indicates some of the impacts of larger water transfer schemes.

The following PINs may be relevant:

TE/WR/001 *Licences of entitlement*
TE/WR/005 *Abstraction licensing*
TE/WR/006 *Measurement and monitoring of water abstraction*

## 9. Points of large discharge

The Discharge Consents Manual is an essential source of reference.Guidance on UWWT Directive implementation and the draft disinfection policy may also be useful.

Various PINs may also be relevant.

## 10. STWs

This note concentrates on the building and extension of STWs. Aspects of operational discharges are covered comprehensively in the Discharge Consents Manual which includes AMP2 guidelines. UWWT Directive implementation guidelines and the draft disinfection policy may also be useful.

NRA R&D outputs, particularly the series of reviews of advances in wastewater treatment, may be relevant to STW design. These include:

Note 78 Commonly used processes for solids separation, biological treatment and chemical phosphorus removal (1992)

Note 79 Process variants for biological nutrient removal, disinfection and tertiary solids removal (1992)

Note 80 Process variants for secondary treatment and chemical phosphorus removal (1992)

Note 164 Process variants for nutrient removal and physical chemical treatment of ammonia (1993)

Note 194 Package plant variants for small works (1993)

## 11. Large residential developments

Relevant Pollution Prevention Guidelines should be issued, such as the following.

1 General guide to the prevention of pollution of controlled waters
2 Above ground oil storage tanks
3 The use and design of oil separators in surface water drainage systems
4 Disposal of sewage where no mains drainage is available
5 Works in, near or liable to affect watercourses
6 Working at demolition and construction sites
8 Safe storage and disposal of used oils
11 Industrial sites
15 Retail premises
16 Schools and other educational establishments

The Procedural Manual *Development in sewered areas* (SC/EQ/008 - in draft, January 1995), Flood Plain Policy (also in draft) and the Discharge Consents Manual may be useful sources of reference.

Outputs from CIRIA research projects RP 448 *Manual on infiltration methods for stormwater source control* and RP 416 *Cleaning sediment from sewerage and drainage systems and above-ground areas*may be relevant when available.

## 12. Large industrial/manufacturing

A report by the United Kingdom Environmental Law Association and Institute of Environmental Assessment Working Party on EA and IPC Overlaps in the *Requirement for Environmental Assessment* describes those prescribed processes requiring application of IPC in the context of the requirements of the EA regulations. It should be remembered that IPC is more limited in scope than EA.

The Discharge Consents Manual may be an essential source of reference.

Various PINs may be relevant including SC/CC/009 *Consenting of dangerous substances in discharges to surface waters.*

Planning Policy Guidance PPG 23 on *Planning and Pollution Control* may be relevant to both NRA and developers.

Outputs from CIRIA research project RP 448 *Manual on infiltration methods for stormwater source control* maybe relevant when available.

Relevant Pollution Prevention Guidance includes:

11 Preventing pollution on industrial sites
18 Pollution prevention measures for the control of spillages and fire-fighting runoff.

## 13. Golf courses

As the Water Resources Act 1991 does not differentiate between the need for irrigation of crops or sporting turf, at least one Region has had to use Section 19, i.e. the duty to secure the proper use of water resources, to defend an approach of allocating water to irrigate greens and tees only. However, this policy is being challenged (pers. comm. Tony Matthews, Southern Region).

Various pollution prevention guidance may be relevant.

## 14. Power stations

Both the *Discharge Consents Manual* and the *Licensing Manual (Water Resources)* may be essential sources of reference.

Guidance notes on points of large discharge and points of large abstraction may also be relevant and should be issued to developers.

An R&D report, Note 200 *Flue gas desulphurization effluents: Priorities for Environmental Quality Standard development* may be relevant.

## 15. Wind farms

No further details

## 16. Hydropower

The following may be relevant:

- Licensing Manual (Water Resources)
- National Rivers Authority *Hydropower Devepments: a handbook for NRA staff.*
- TE/WR/0013 *Hydropower developments*

Abstraction licences should be time limited.

## 17. Oil refineries/exploration

The Discharge Consents Manual may be an essential source of reference.

The video *Pollution Prevention Pays* may be relevant. This was available as a video offer.

Separate guidance is available for pipelines which may be appropriate.

Under the terms of the Environmental Protection Act 1990 authorization from HMIP is required for prescribed processes under Integrated Pollution Control. These include petroleum and petrochemical processes.

In instances of proposed offshore developments, the NRA should co-ordinate its requirements with MAFF who have a more general remit in the offshore environment.

The NRA should consider its position regarding the UK Offshore Chemical Notification Scheme OCNS, which can be at variance with normal NRA practice ( pers. comm., Andrew Wither). OCNS is currently a voluntary code, but is likely to become mandatory under the OSPARCOM 'CHARM' initiative.

There is currently (1995) controversy over proposals to dispose of a decommissioned (and contaminated) platform at sea.

## 18. Forestry

A number of R&D outputs may be relevant to NRA staff (available via Regional R&D Co-ordinators).

| Project | Report N° | Title | Date |
|---|---|---|---|
| 003 | P-22 | Impact of lowland forestry on water quality | 1990 |
| 004 | P-39 | Review of the effects of afforestation on upland water quality | 1990 |
| | P-79 | Nutrient enrichment of Scottish lochs and reservoirs, with particular reference to the impact of forest fertilization | 1990 |
| 114 | Note 77 | Forestry impact on upland water quality | 1992 |
| | Project Record 114/5/W | Forestry impact on upland water quality - Supporting studies | 1992 |
| | Project Record 230/16/W | Assessment of forestry buffer strips | 1994 |
| 422 | Note 156 | A review of water quality implications of conifer harvesting in the UK<br>1. Literature review and recommendations for research | 1993 |
| | Note 159 | A review of water quality implications of conifer harvesting in the UK | 1993 |
| | | 2. Unpublished results from ITE clearfelling studies and management options | 1993 |
| 115/102 | Note 56 | Hydrological impacts of broadleaf woodlands - Implications for water use and quality | 1992 |
| | Project Record 115/3/ST | Implications for water use and quality | 1992 |

## 19. Redevelopment of contaminated land

The NRA has a National Waste Disposal & Contaminated Land Group, chaired by Mike Beard (NRA Southern Region).

Provisions for contaminated land have been put forward in the Environment Bill which may affect the legislative framework.

The Discharge Consents Manual may be a useful source of reference.

## 20. Waste management

The Discharge Consents Manual may be a useful source of reference. The NRA Pollution Prevention Manual contains very detailed guidance on the conditions sought for the protection of the environment from various waste disposal processes.

There is a relevant NRA procedural manual or PM, SC/CC/013 *Controlled waste: the duty of care.*

An HMIP waste management paper Environmental Assessment of Waste Disposal Facilities (issued as a consultation draft in 1989) may be useful for further guidance.

Strategically, the waste disposal proposal should be part of, or fit in with, wider disposal strategies at a local or national level.

Other relevant guidance notes include:

- restoration of mineral extraction sites;
- mining and quarrying;
- redevelopment of contaminated land; and
- tipping/dumping (scoping only).

## 21. Mineral extraction

The NRA has a National Waste Disposal & Contaminated Land Group, chaired by Mike Beard (NRA Southern Region).

The Discharge Consents Manual may be a useful source of reference.

Further relevant guidance may be found in the following:

Minerals Planning Guidance Note 2 - *Applications, Permissions and Conditions*, 1988;
DoE Circular 30/92 - Development and Flood Risk;
DoE Circular 2/85 - Planning Control over Oil and Gas Operation; and
EC Directive on the Protection of Groundwater (80/68/EC).

Also, British Coal had a Framework Policy on the Environment prior to privatization of the coal industry. It is be possible that new coal producers would be required to follow these policies.

## 22. Restoration of mineral extraction sites

The NRA has a National Waste Disposal & Contaminated Land Group, chaired by Mike Beard (NRA Southern Region).

Other relevant scoping guidance includes:

- conservation enhancement
- tipping/dumping
- mineral extraction
- redevelopment of contaminated land

The Discharge Consents Manual may be an useful source of reference.

An R&D output, AEA-EE-0109 *Survey of drainage practices in landfilled wastes*, may be relevant.

## 23. Roads

Various research has been conducted on the suitability of various imported materials for use in embankments in association with the Second Severn Crossing. These materials included china clay waste, smelter waste and Pulverised Fly Ash (PFA). Research included the leachability of contaminants from such materials and appropriate engineering options (e.g. capping) to minimize risks of pollution. Contact: Barry Fisk, South Western Region.

There is currently in draft a Highways Agency CHE Memorandum XX/94 - *Liaison with National Rivers Authority on highway construction and maintenance schemes*. In addition, a proposed "Letter of Agreement" between the Highways Agency and the NRA is expected to be finalized in April 1995. This will require works to be carried out in accordance with designs approved by the NRA. This letter should be exchanged at the "road order" stage (pers. comm. John Lambert, Welsh Region).

The NRA standard road construction "special requirements" should be issued if appropriate.

Relevant NRA Pollution Prevention Guidelines should be issued, particularly:

2 Above ground oil storage tanks
3 The use and design of oil separators in surface water drainage systems
5 Works in, near or liable to affect watercourses
6 Working at demolition and construction sites
9 Pesticides

The Discharge Consents Manual may be a useful source of reference as may SC/CC/014 *Drainage for motorways, highways and all other roads*.

Other references:
Cobham Resource Consultants (1993) Blackwater Valley River Diversion. Environmental Statement. CRC, Abingdon.

Cobham Resource Consultants (1993) Blackwater Valley. Environmental Statement (Supplementary). CRC, Abingdon.

Ellis, J.B. and Revitt, D.M. (1991) *Drainage from Roads: Control and Treatment of Highway Runoff*. Report to NRA. Middlesex Polytechnic.

## 24. Railways

Various research has been conducted on the suitability of various imported materials for use in embankments in association with the Second Severn Crossing. These materials included china clay waste, smelter waste and Pulverised Fly Ash (PFA). Research included the leachability of contaminants from such materials and appropriate engineering options (e.g. capping) to minimize risks of pollution. Contact: Barry Fisk, South Western Region.

Union Railways (1994) Environmental Handbook.

The ES for the Channel Tunnel Rail Link is available, although this has been criticized by NRA staff

The NRA Discharge Consents Manual may be a useful source of reference.

Various Pollution Prevention Guidance may be relevant.

also C Bolton
CIRIA project
↳ RP495

NRA 537
A09(9411

## 25. Airports

The NRA should insist upon a Method Statement being developed by developers/contractors to make clear that contingency plans etc. have been put in place.

The Discharge Consents Manual may be a useful source of reference. Also, there are Pollution Prevention Guidelines on airfields (currently in draft). In addition, the following Pollution Prevention Guidelines may be relevant:

2 Above ground oil storage tanks;
3 The use and design of oil separators in surface water drainage systems; and
9 The prevention of pollution of controlled waters by pesticides

## 26. Cemeteries

Some of the principles applied to the siting and operation of cemeteries will be common to those applying to the disposal of animal carcasses. Therefore, guidance provided in the *Code of Good Agricultural Practice for the Protection of Water* (MAFF 1991) and SC/EQ/006 may also be relevant.

## 27. Navigation issues

Pollution Prevention Guidelines 14 - Inland waterways: marinas and crafts should be issued where relevant.

Thames Region have produced (1994) *River Thames recreation strategy* which may be a useful source of reference.