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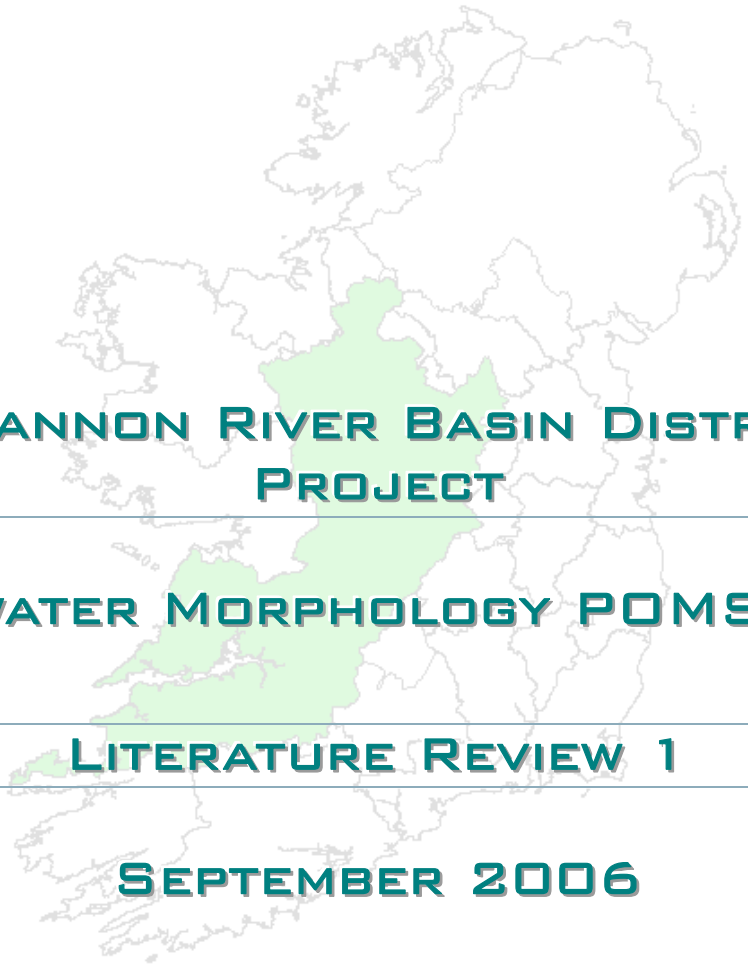


Shannon River Basin District Project

Freshwater Morphology POMS Study

Literature Review 1

September 2006

Document Number: DC060

SHANNON RIVER BASIN DISTRICT PROJECT

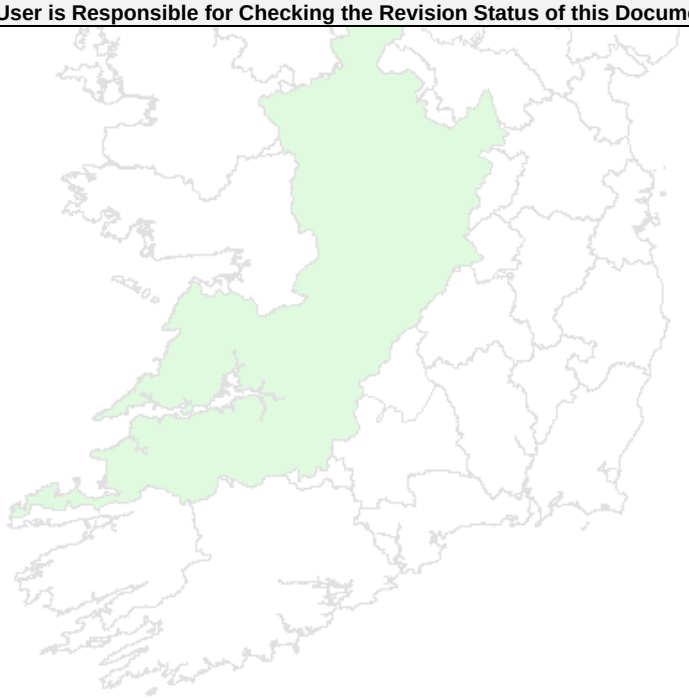
Freshwater Morphology POMS Study – Literature Review 1

This is a report which summarises those documents relating to freshwater morphology available to the project team between October 2005 and August 2006. Key findings in guidance and research documents and applicability to the overall Freshwater Morphology POMS Study are highlighted. Subsequent literature reviews will be produced as the Study progresses and further information on a national and European basis becomes available.

REVISION CONTROL TABLE

Rev.	Description of Changes	Prepared by	Checked by	Approved by	Date
0	Issued for comment	LH	GG	AGB	29.09.06
1	Comments made by Project Co-ordinator addressed; Summary of documents reviewed appended	LH	ET	GG	22.1.07
2	Summary of key applications added (Chapter 7.0) Year of publication added to Appendix I	LH	ET	GG	13.2.07
3	Steering Group comments incorporated	LH	GG	AGB	22.3.07

The User is Responsible for Checking the Revision Status of this Document



Contents

Glossary of Terms

AWB	Artificial Water Body (pAWB indicates provisional AWB)
EHS	Environment and Heritage Service (NI)
EPA	Environmental Protection Agency (RoI)
ERBD	Eastern River Basin District
EU	European Union
GEP	Good Ecological Potential (for HMWB and AWBs)
GES	Good Ecological Status
HMWB	Heavily Modified Water Body (pHMWB indicates provisional HMWB)
IRBD	International River Basin District
MImAS	Morphological Impact Assessment System
Mitigation Measures	Measures taken on a waterbody to generate Good Ecological Potential
NS SHARE	North- South Shared Aquatic Resource Project
NBIRBD	Neagh Bann International River Basin District
NERBD	North Eastern River Basin District
NI	Northern Ireland
NWIRBD	North Western International River Basin District
OPW	Office of Public Works
P&I	Pressures and Impacts
PoM	Programme of Measures
POMS	Programmes of Measures and Standards
R.A.T	Rapid Assessment Technique
RBD	River Basin District
RBMP	River Basin Management Plan
Restoration Measures	Measures taken on a waterbody to reach Good Ecological Status only
RHS	River Habitat Survey
RoI	Republic of Ireland
SERBD	South Eastern River Basin District
SHIRBD	Shannon International River Basin District
SWRBD	South Western River Basin District
UK TAG	United Kingdom Technical Advisory Group
WFD	Water Framework Directive
WRBD	Western River Basin District

1.0 Introduction and Background

This literature review has been completed under Work Package 1 of the Shannon River Basin District, Freshwater Morphology, Programmes of Measures and Standards (POMS) Study Terms of Reference as agreed in October 2005.

In the Republic of Ireland (RoI) and Northern Ireland (NI), risk assessment was undertaken in accordance with the requirement, under Article 5 (1) of the WFD for Member States to carry out, for each River Basin District, *"a review of the impact of human activity on the status of surface waters and groundwaters*". The identification of significant morphological alterations to waterbodies is listed in Annex II of the WFD as a specific pressure which had to be addressed in the risk assessment.

In accordance with the WFD, Good Status for surface waters is defined as:

Good Ecological Status plus Good Chemical Status

Ecological Status comprises the following elements:

- Biological elements
- Chemical and physico-chemical elements supporting the biological elements
- Hydromorphological elements supporting the biological elements

More specifically, morphological elements supporting the biological elements include river depth and width variation; structure and substrate of the river bed; and structure of the riparian zone. For lakes, morphological elements supporting the biological elements include lake depth variation; quantity, structure and substrate of the lake bed; and structure of the lake shore. Alterations to these conditions constitute human impact on the status of surface waters.

In the WFD, hydromorphological elements contribute to status classification, only to distinguish between high and good ecological status.

However, knowledge of a waterbody's hydromorphological conditions, regardless of status is important for the following reasons:

- For analysis and investigation into why waterbodies fail to reach good ecological status and what direct (river management) and indirect (catchment management) practices are required to lead to improved status;
- To prevent the deterioration in ecological status of a waterbody;

- Characterisation of Heavily Modified Water Bodies (HMWBs) and Artificial Water Bodies (AWBs);
- Setting appropriate monitoring standards.

2.0 Article 5 Morphological Risk Assessment

2.1 Republic of Ireland Methodology

In the RoI drivers with the potential for causing pressures on morphological conditions were identified for rivers and lakes as indicated in Table 2.1 and Table 2.2.

Table 2.1: Morphological Drivers Exerting Pressure on Rivers - RoI

Morphological Driver	Description
Channelisation and dredging	Silt and substrate removal for bed slope, side slope and depth of flow changes to the channel for drainage purposes.
Flood protection and embankments	The protection of lands adjacent to the water body from flooding by the presence of built embankments comprised of river bed and other material.
Impounding	Backing-up of water through the presence of constructed dams.
Water regulation	Regulation of water flow through the introduction of locks, weirs, sluices.
Intensive land use	Peat extraction areas, coniferous forests, arable land, urban areas.

Table 2.2: Morphological Drivers Exerting Pressure on Lakes - RoI

Morphological Driver	Description
Channelisation and dredging	Silt and substrate removal for bed slope, side slope and depth of flow changes to the channel for drainage purposes.
Flood protection and embankments	The protection of lands adjacent to the water body from flooding by the presence of built embankments comprised of bed and other material.
Impounding	The presence of a constructed dam to prevent or control the outflow of water from a lake.
Intensive land use	Peat extraction areas, coniferous forests, arable land, urban areas.

Datasets relating to each of these activities were collected from various authorities throughout RoI and NI such as the Office of Public Works (OPW); DARD Rivers Agency; Environmental Protection Agency (EPA); and Environment and Heritage Service (EHS). The Article 5 morphological risk assessment involved applying a set of thresholds to the pressure datasets, where each threshold defined a specific risk category. All assessments were considered on a "waterbody" level which is the key management unit.

A two stage approach was implemented. Stage 1 involved the determination of risk magnitude and Stage 2 was an adjustment based on data confidence. Risk magnitude of an individual waterbody was divided into four categories:

- (1a) – At risk of failing to meet WFD objectives by 2015
- (1b) – Probably at risk of failing to meet WFD objectives by 2015
- (2a) – Probably not at risk of failing to meet WFD objectives by 2015
- (2b) – Not at risk of failing to meet WFD objectives by 2015

The risk category of each waterbody was determined by taking the worst case from a range of pressure assessments and was reported to the European Commission in March 2005.

2.2 Northern Ireland Methodology

Tables 2.3 and 2.4 summarise the identified drivers with the potential for causing pressures on morphological conditions of rivers and lakes in NI.

The Article 5 morphological risk assessment was conducted using a number of datasets. River Habitat Survey (RHS) information was used to assess approximately 50% of NI's waterbodies. In addition, a map-based approach was used to identify additional pressures such as river straightening, land-use pressures, shoreline reinforcement and land reclamation (Source: Water Framework Directive Summary Report of the characterisation impact analyses required by Article 5 in Northern Ireland).

Table 2.3 - Morphological Drivers Exerting Pressure on Rivers - NI

Morphological Driver	Description
River substrate manipulation	Removal of silt and/or substrate from a river channel – includes dredging for navigation, for creating on-line ponds and for fisheries enhancement e.g. pool creation; addition of gravel for spawning areas
Bed and bank reinforcement	Strengthening of river beds for various purposes (e.g. ford construction, erosion control); flood protection using flood walls, embankments; bank protection using gabion baskets, boulders, sheet piling, wood, willow spiling, geotextiles, etc.
River re-sectioning	Re-profiling of bank-face, changes to gradient of channel bed, introduction of artificial substrate
River straightening	Engineering to produce ditch-like channels
River realignment	Removal of meanders: increase in channel gradient, flow velocity, flood capacity
River channelisation	Straightening, widening, and deepening of channel
Culverting	Complete enclosure of river channel, often impassable to fish
Flow manipulation	Placement of boulders, deflectors, etc. for redirecting pattern of water flow
Impounding	Backing-up of water through the construction of dams, weirs, sluices, fords, etc.
Construction	Building instream structures for a range of purposes – structures include outfalls, jetties, piers, boat slipways, flood relief channels, flood storage areas, bridge supports

Intensive use	Grazing, removal of riparian vegetation, management of riparian vegetation, poaching, erosion from boat traffic
Removal of natural barriers	Removal of waterfalls and other instream natural barriers, usually to permit upstream fish migration
Modifications to sediment regime	Poor catchment land management leading to increases in sediment and water run-off
Floodplain modification	Construction of flood banks limiting channel and floodplain interactions

Table 2.4 - Morphological Drivers Exerting Pressure on Lakes - NI

Morphological Driver	Description
Bank construction and reinforcement	Flood or erosion protection using flood walls, embankments; bank protection using gabion baskets, boulders, sheet piling, wood, willow spiling, geotextiles, etc.
Channelisation of inflows and outlets	Straightening, widening, and deepening of channel at approach to river mouths and outlets
Impounding	Backing-up of water through the construction of dams, weirs, sluices, fords, etc.; artificial water level regime
Lowering/draining	Lowering by cutting outlet, often for land claim
Construction	Building structures for a range of purposes – structures include outfalls, jetties, piers, boat slipways, bridge supports
Intensive use	Grazing, removal of riparian vegetation, management of riparian vegetation, poaching, erosion from boat traffic
Intensive macrophyte management	Removal or excessive growth of macrophyte beds in littoral/sublittoral areas.
Modifications to sediment regime	Poor land management leading to increases in sediment and water run-off

2.3 Article 5 Morphological Risk Assessment Results

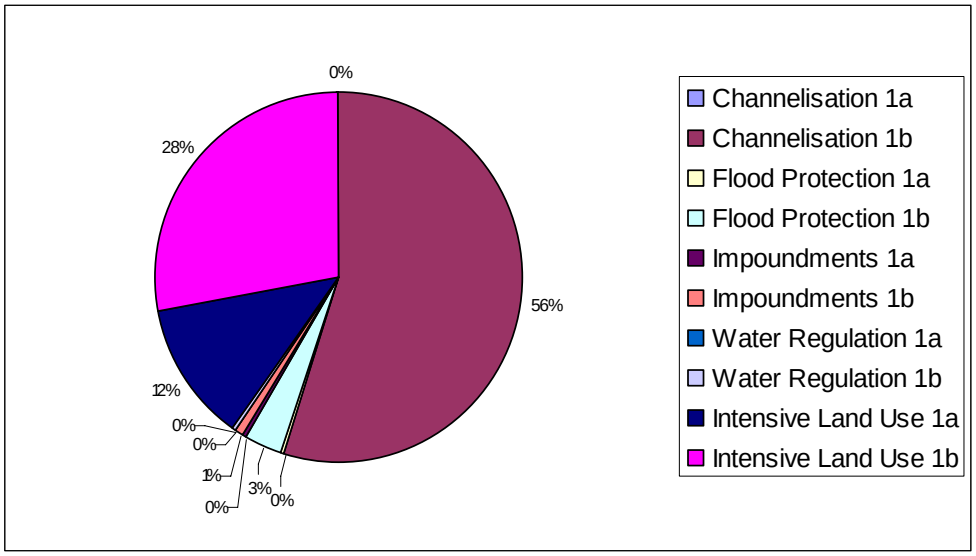
Morphology pressures were identified across many Member States as exerting significant pressures which might result in waterbodies failing to achieve their WFD status objectives (Source H Bloech WFD Conference, Budapest, May 2005).

2.3.1 Republic of Ireland Results

Within RoI's Article 5 Report, freshwater morphology pressures accounted for placing 1720 (or 38.5%) of river waterbodies "at risk (1a) or "probably at risk (1b)" and 135 (or 18.1%) of lake waterbodies "at risk (1a)" or "probably at risk (1b)".

The pie chart below represents the morphological activities resulting in "at risk" or "probably at risk" categorisation of river waterbodies in RoI (A river waterbody is a sub-division of a larger river catchment and is the basic compliance, reporting and management unit for the WFD).

Figure 1: RoI Significant Morphology Pressures (Rivers)



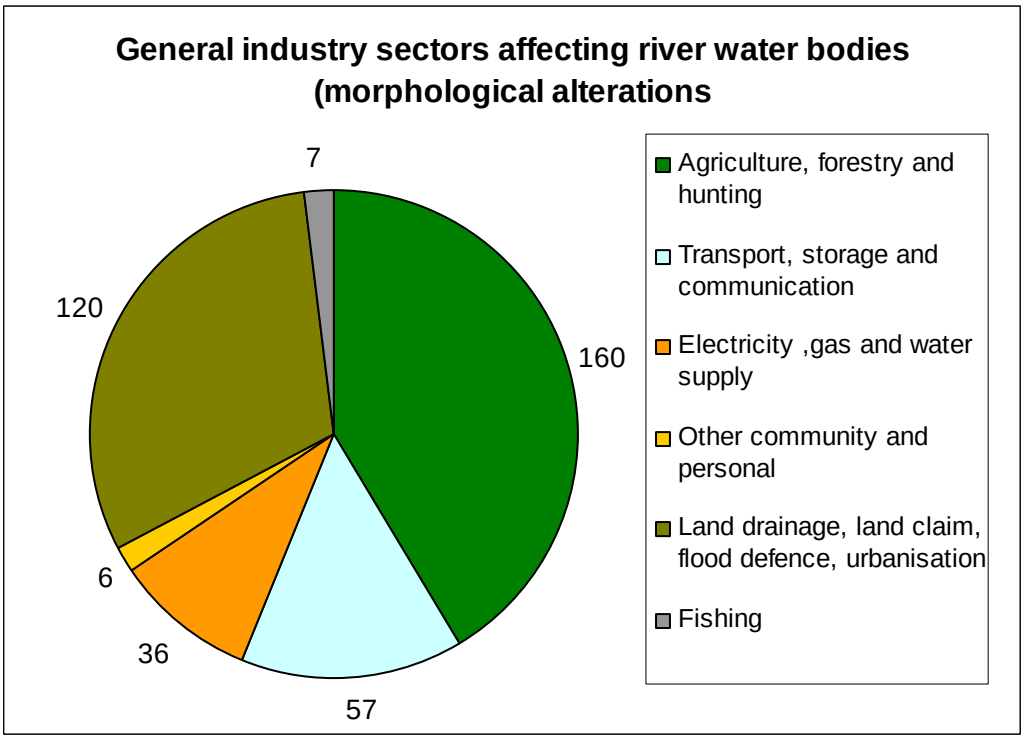
The ***Channelisation*** assessment resulted in 1047 waterbodies being placed "probably at risk" nationally. The ***Intensive Land Use*** assessment which represents "indirect" morphology pressures due to catchment land use change is the second most significant assessment nationally with 773 water bodies either "at risk" or "probably at risk".

2.3.2 Northern Ireland Results

Within NI's Article 5 Report, morphology pressures accounted for placing 380 (or 69.1%) of river waterbodies "at risk (1a) or "probably at risk (1b)" and 15 (or 62.5%) of lake waterbodies "at risk (1a)" or "probably at risk (1b)".

The identification of morphological activities or drivers exerting pressure on waterbodies differed between NI and RoI as illustrated by Tables 2.1 to 2.4. Figure 2 represents the significant industry sectors resulting in "at risk" or "probably at risk" categorisation of river waterbodies in NI.

Figure 2: NI Significant Industry Sectors Placing Waterbodies at Risk – 1a & 1b (Rivers) Source: EHS Article 5 Risk Assessment Results



The “Land drainage, land claim, flood defence and urbanisation” assessment encompasses river re-sectioning and dredging and is comparable to the “channelisation” assessment in RoI. This resulted in 105 waterbodies being placed “at risk” or “probably at risk”. “Agriculture (mainly arable and improved pasture) and Forestry”, which is comparable to “Intensive Land Use” assessment in RoI and represents indirect morphology pressures due to catchment land use change, resulted in 116 waterbodies being placed “at risk” or “probably at risk”.

Therefore in NI, channelisation and intensive land use pressures have also emerged as most significant in placing waterbodies at risk of failing to achieve WFD objectives by 2015.

3.0 Freshwater Morphology POMS Study Objectives

3.1 Primary Objective

Specifically with regard to historical channelisation and dredging works and ongoing maintenance dredging in RoI there is uncertainty as to the long term impacts of these activities. Similarly, there is limited data within NI on the extent of morphological alterations to rivers and lakes. Techniques for describing and assessing the morphological condition of surface waters are currently being developed and are not widely applied. The overall approach to Article 5 risk assessment was precautionary because of the limited data available and the poor understanding of the relationships between morphology and ecology. This resulted in a significant amount of waterbodies being categorised as "1b -probably at risk" or "2a -probably not at risk".

Therefore, the primary objective of the Freshwater Morphology POMS Study is to resolve the uncertainties identified in the Article 5 reports in relation to the two key freshwater morphology assessments (i.e. channelisation and intensive land use). Fieldwork and examination of pressure and impact relationships will refine the risk assessments and thresholds applied.

The revised thresholds will be reapplied on behalf of all RBDs in early 2007 to provide output for the Significant Water Management Issues (SWMI) report in June 2007. In addition, measures for inclusion in the first River Basin Management Plan (RBMP) will be developed where appropriate.

3.2 Secondary Objective

Both RoI and NI used the same principles in applying methods for the determination of risk in the morphological risk assessment. The methodology comprised of two stages:

- Stage 1: determination of risk magnitude;
- Stage 2: adjustment based on data confidence.

However, as illustrated in the Article 5 risk assessment methodologies and results, there were differences in the datasets used and the morphological activities assessed to define morphological alterations as an overall pressure. To this end, the achievement of harmonisation in risk assessments between NI and RoI will be addressed within the overall POMS Study as a secondary objective. The outcome of this will be presented in subsequent Work Package deliverables as they are progressed.

4.0 Literature Review Objectives and Scope

Several documents have been collated for inclusion in the literature review. The main objective is to identify the scope of relevant ongoing research and to draw upon significant findings with respect to monitoring, regulatory measures and decision support tools for regulators.

Each of the documents studied will contribute information to one or more of the following categories within this literature review:

- Guidance Documents
- Research and Morphology Applications

An indication of how the documents reviewed apply to the objectives of the Freshwater Morphology POMS study will be provided within this report.

Based on the Article 5 risk assessment results discussed in Section 2.0 and the overall Freshwater Morphology POMS Study objectives identified in Section 3.0, the main focus of the Literature Review will be on channelisation and intensive land use pressures with respect to each of these categories.

The documents reviewed in this initial report are predominantly UK and Ireland based, sourcing available literature within each category. However, some of these documents provide information on methodological approaches developed worldwide (e.g. Document 6.4). It is envisaged that subsequent updates of the literature review report will be prepared throughout the development of the Freshwater Morphology POMS Study incorporating further literature and research from UK and Ireland but also from other EU Member States. As information from ongoing research becomes available over time, significant findings will be incorporated as appropriate.

Best practice measures will be reviewed in a separate report.

5.0 Guidance Documents

Table 5.1 indicates the Guidance documents that have been reviewed to date.

Table 5.1: Guidance documents that have been reviewed to date

Document Number	Document	Author
5.1	Pressure and Impacts Analysis – Policy Summary (IMPRESS)	CIS
5.2	EHS P&I Task 4.1 - Water Quality Impact from Morphological Changes – risk assessment methodology	Environment and Heritage Service
5.3	Morphological Risk Assessment - Guidance on thresholds and methodology to be applied in Ireland's River Basin Districts.	South Eastern RBD
5.4	NS SHARE – Comparison of Risk Assessment Methodologies used in Northern Ireland and Republic of Ireland (NS Share R-01-A)	RPS Consulting Engineers
5.5	WFD and Hydromorphology, European Workshop, Prague, Workshop Summary Report	E Kampa & N Kranz

Documents 5.1 – 5.4

Article 5 Risk Assessment (Pressure and Impact Analysis) - Guidance Documents

During Article 5 Risk Assessment, guidance documents were produced to advise Member States on how to effectively implement the WFD requirements in terms of Risk Assessment and Pressure and Impact Analysis.

The **IMPRESS** document (**Document 5.1**) provided a summary on the various ecological objectives to be achieved, the timetable for WFD implementation, and an explanation of the key elements within the Pressure and Impact Analysis. Figure 3 overleaf has been extracted from this document to illustrate the WFD implementation process and was provided as guidance to all Member States.

With respect to Article 5 morphological risk assessment in RoI and NI, guidance documents were developed to provide methodologies, dataset requirements and morphological activities to be assessed within each jurisdiction (**Documents 5.2 and 5.3**).

In RoI and NI, the Article 5 risk assessment (initial Annex II Pressure and Impact analysis as shown on Figure 3) has been completed. However, assessment of Pressure and Impact on waterbodies must continue in order to provide input to the first River Basin Management Plan (RBMP) in 2009 and subsequent six-yearly plans.

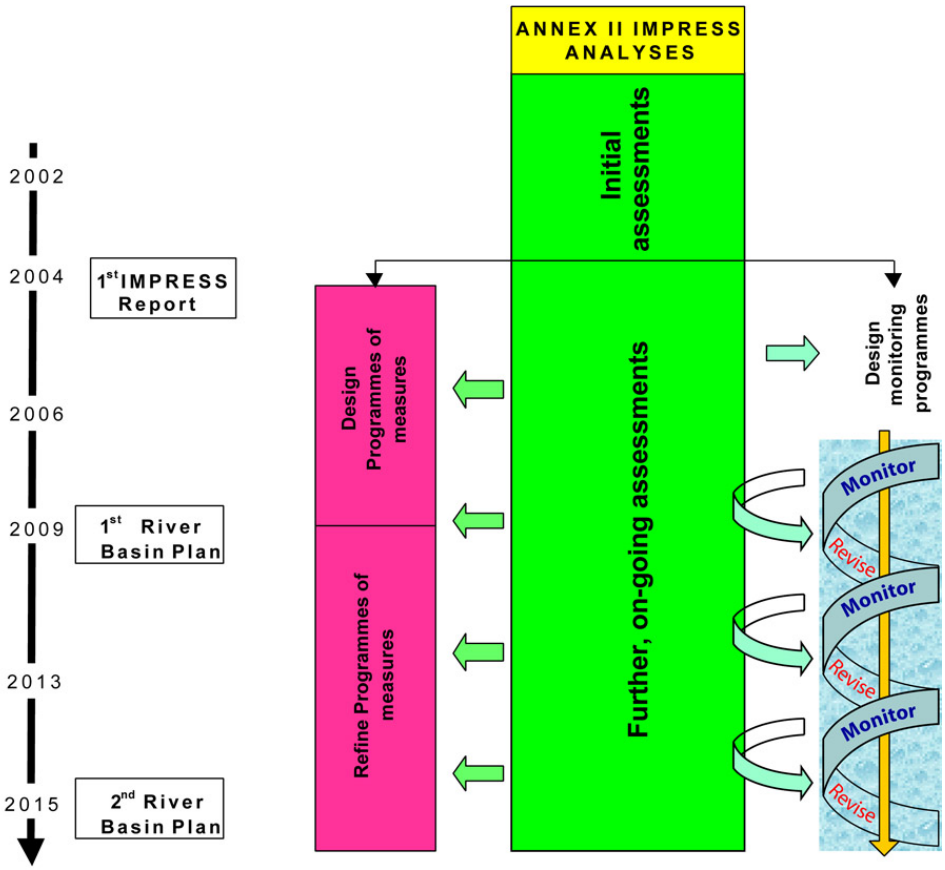


Figure 3: WFD Implementation Process – Pressures and Impacts are an ongoing cycle within this (Source: CIS, Pressure and Impacts Analysis – Policy Summary (IMPRESS))

As indicated by Figure 3, an intermediary deliverable between "further ongoing assessments" and the production of RBMP's is the development of "Programmes of Measures and Standards" (POMS) to achieve Good Ecological Status (GES) for waterbodies at risk of failing to meet WFD objectives, or to prevent deterioration of waterbodies considered to exhibit GES at present.

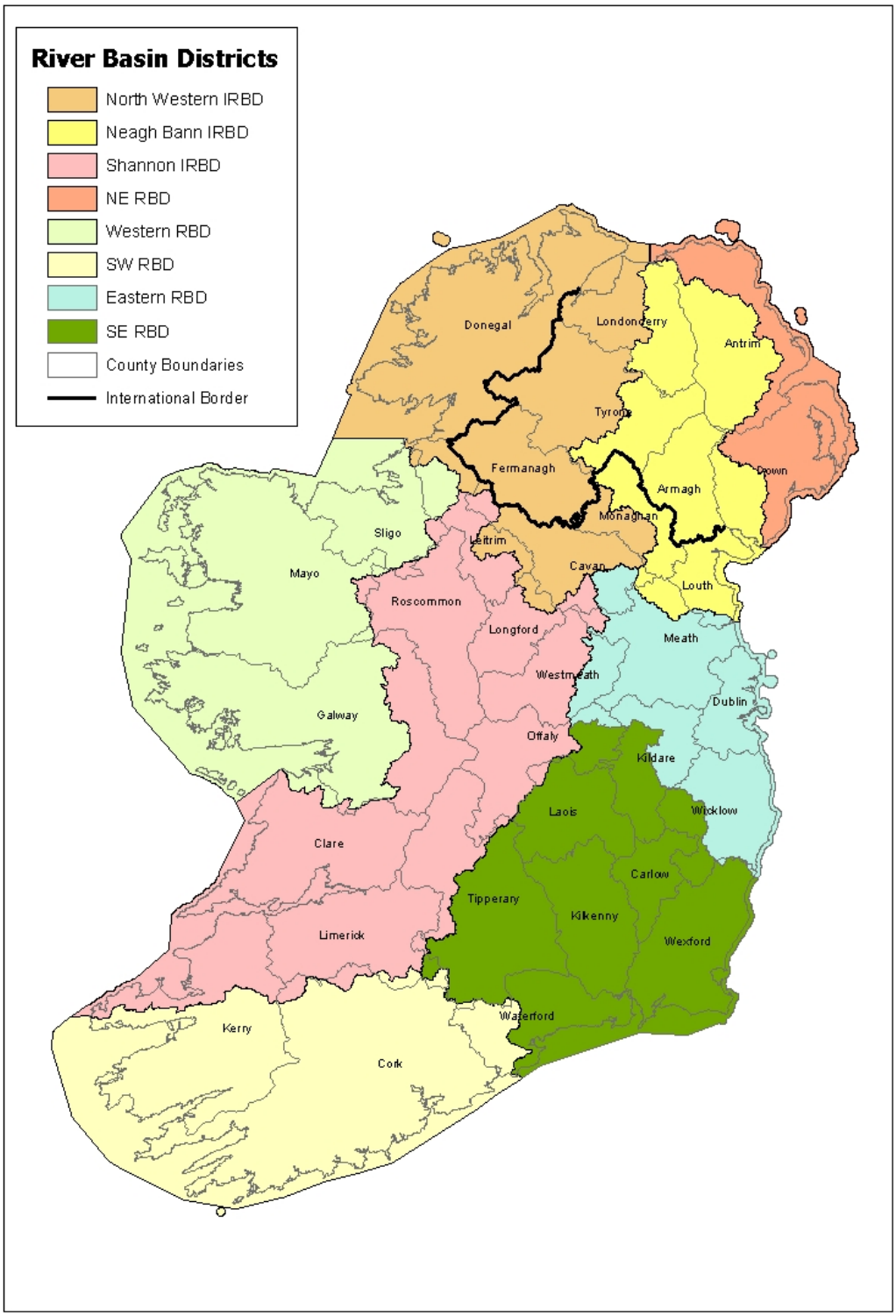
In RoI and NI, two parallel studies have been commissioned to facilitate this implementation process for rivers and lakes with respect to morphological alterations in the eight (I)RBD's in the island of Ireland.

- **Freshwater Morphology POMS Study** - Administered through the Shannon International River Basin District (IRBD) and also encompassing South West RBD, South East RBD, Western RBD, Eastern RBD

- **Further Characterisation Activities, Freshwater Morphology** – Administered through the North South Shared Aquatic Resource Project (NS SHARE) and

encompassing North Western International RBD; Neagh-Bann International RBD; and North- Eastern RBD.

Map 1 indicates the various (International) RBD boundaries in RoI and NI.



Map 1: River Basin Districts (RBDs) in Ireland and Northern Ireland

Within both Freshwater Morphology studies, ongoing assessment in the form of fieldwork and remote sensing will refine the initial Pressure and Impact Analysis undertaken, and provide input to the proposed Programmes of Measures for inclusion in the first RBMP in 2009.

This approach demonstrates co-ordination of administrative arrangements both within and between (I) RBD's, which is critical to the successful implementation of the Water Framework Directive as discussed in Article 3 of the Directive,

"*Member States should ensure that the requirements of the Directive for the achievement of environmental objectives established under Article 4 are coordinated for the whole of the river basin district*. *For international river basin districts the Member States concerned shall together ensure this coordination…"*

This also applied during Article 5 risk assessment and it was essential that the competent authorities in both RoI and NI attempted to harmonise, as far as is possible, the approaches adopted.

The North South Shared Aquatic Resource Project (NS SHARE) facilitated the production of **Document 5.4** which drew comparisons between the Article 5 risk assessments methodologies used in each jurisdiction. The main differences in the morphological risk assessment were in the morphological activities used to assess morphological risk to waterbodies and in the corresponding datasets collated which were dependent on availability.

Document 5.5

Further Characterisation Guidance

The importance of hydromorphological pressures on waterbodies has been highlighted across Member States in the Article 5 reports. In response, the EU Water Directors agreed to initiate a new activity on the WFD and hydromorphology as part of the Common Implementation Strategy. To begin this CIS work, a European workshop was held in Prague in October 2005 with over 100 delegates from 24 Member States in attendance. The summary report from this workshop has been the first CIS deliverable from the WFD and Hydromorphology mandate.

The focus of the mandate is on navigation, hydropower and flood defences as these morphological alterations were identified as significant in exerting pressure on waterbodies throughout Europe. There are items of relevance within the Prague Workshop Summary Report which have been drawn upon for the purposes of this Literature Review.

Policy Integration – Key Points

- Policy integration is necessary between Water Policy makers and Policy makers concerning other river or lake uses. Policy integration is needed at both a regional and RBD level;
- Other policies, e.g. agricultural policy should seek to promote the principles of protection, restoration and mitigation in accordance with the WFD;
- An appropriate balance must be achieved between waterbody protection under WFD and other water uses such as recreation or hydropower;
- There needs to be a clear link between restoration / mitigation measures and planning;
- Restoration measures for smaller waterbodies tend to be more site specific and integrated approaches are more difficult to apply across EU.

Further Characterisation (POMS) – Key Points

- The feasibility of using fish and macrophytes as biological indicators of morphological condition should be explored;
- Research projects should be initiated to establish a link between hydromorphology and biology;
- Clarification of waterbodies categorised as “probably at risk” is required;
- Development of a morphological classification system is needed.

Programmes of Measures – Key Points

- Navigation, hydropower and flood defence were the focus of the Workshop;
- Flood defence as discussed at the Workshop, encompasses land drainage which was significant in Northern Europe, including RoI and NI. This is comparable to the channelisation assessment undertaken in RoI and the map screening and flood bank assessments undertaken in NI;
- The application of engineering solutions for some flood defence problems is uneconomic;
- Latest thinking on making space for river and coastal flooding using soft engineering solutions is compatible with WFD objectives of restoration to Good Ecological Status;
- In Flood Risk Management, use should be made of the administrative arrangements being established for the RBMP’s. Environmental improvements should be timed to coincide with work on flood defence structures.

6.0 Research and Development of Morphological Assessment Applications

Under Article 11 of the WFD, by 2009, Member States need to develop a Programme of Measures (POMs) for each River Basin District (RBD) taking into consideration the results of both initial characterisation (Article 5) and further characterisation.

A Programme of Measures implemented at a national or local level within Member States may include wide-ranging actions such as:

- measures to manage specific pressures arising from: forestry, agriculture, urban development, etc;
- control regimes or environmental permitting systems;
- water demand management measures;
- economic instruments such as incentives, taxes on fertilizers, etc;
- river restoration strategies.

(Source: http://www.wfduk.org/tag_guidance/Article%20_11/)

Programmes of Measures (as specified in RBMP's) are required to be operational by 2012. Competent authorities (supported by UKTAG) are reviewing the requirements of the WFD in this area. UKTAG, via its Programme of Measures Task Team, is reviewing how the requirements of the WFD can be met within UK systems for:

- Environmental objectives under WFD;
- Classification schemes and environmental standards which aim to ensure UK regimes are WFD compliant;
- Managing the interaction of WFD with other European directives being implemented by the UK;
- Developing the framework for assessing cost-effective programme of measures.

With respect to freshwater morphology, research in these areas is still developing across Europe. At present research projects are ongoing and proposed both through the UKTAG and in RoI which have relevance to freshwater morphology. Table 6.1 indicates the freshwater morphology related research documents that have been reviewed to date.

Documents 6.1 to 6.3
Freshwater Morphology - Past Research

Table 6.1 Freshwater Morphology Research Documents that have been reviewed to date

Document Number	Document	Author
6.1	ERTDI- Water Framework Directive Characterisation of Ref Conditions and Testing Typology of Rivers (50 refcon sites)	ERTDI –Mary Kelly-Quinn et al
6.2	Linking Catchment Characteristics and Water Chemistry with the Ecological Status of Irish Rivers	Ian Donohue et al
6.3	Freshwater Morphology Workshop – Research Needs, Lancaster University	RPS attended and produced notes for Literature Review

Document 6.1 was sponsored by EPA and undertaken by The Environmental Research Technology and Development Initiative. It is entitled, "*Water Framework Directive Characterisation of Ref Conditions and Testing Typology of Rivers (50 refcon sites)*". The study had 2 objectives:

1. To validate reference sites chosen from Q rated sites of 4-5 or 5 using all biological indicators identified in WFD, not just macro-invertebrates;
2. To develop a typology system (12 identified) and to identify where each reference site studied was placed in it.

Fifty potential reference sites throughout RoI, based on Q ratings, were selected by the EPA for macro-invertebrate, phytobenthos and macrophytes surveys. Two stretches were surveyed at each site, each of which was also visually assessed for reference conditions based on their hydromorphology. Five sites were identified as potentially having hydromorphological impacts, causing deviation from reference condition, as indicated by Table 6.1. However impacts were considered to be very minor at these sites, therefore the report concluded that none should be rejected from the reference sites list due to hydromorphology.

Table 6.2: Potential Hydromorphological Impacts and Potential Reference Sites (ERTDI)

Q Site Name	Q Site Location	Q value	Waterbody Code	County	RBD	Morphological Alteration
Duniry	Just upstream of Cappagh River confluence	4-5	25_668	W. of Portumna, Galway	WRBD	Over-widened
Eanymore Water	Eanymore Bridge	4-5	37_2012	NW of Donegal town	NWIRBD	Disturbed bank
Liffey	0.5km downstream of Ballyward Br	4-5	09_1175	S of Kilbride, Co. Dublin	ERBD	Banks altered/eroded
Moy	At Bleanmore	4-5	34_1935	S of Foxford, Mayo	WRBD	Arterial Drainage – spoil heaps on banks
Owenglin	Bridge S.W. of Clifden Lodge	4-5	32_3028	E of Clifden, Galway	WRBD	Old walls forms part of bank, evidence of fisheries management

Applicability to Freshwater Morphology Study:

The morphological alterations and reference condition status at these sites resulted in their selection for inclusion in the fieldwork aspect of the Freshwater Morphology POMS Study. It is considered that any morphological impact on these sites can easily be isolated and attributed to morphological alterations, as pressures such as point source pollution or abstraction are not present. In addition, their reference condition would provide a benchmark for comparison with other sites of the same typology.

Document 6.2, *"Linking Catchment Characteristics and Water Chemistry with the Ecological Status of Irish Rivers*" was a study relating land use pressures to the ecological status of rivers and was carried out in 2005 by the Freshwater Ecology Group at Trinity College Dublin (TCD). The overall aim of this study was to gain a quantitative understanding of the linkages among catchment attributes, water chemistry and the ecological status of aquatic ecosystems. 797 sites were investigated. An analysis of ecological status was carried out by deriving a biotic index based on benthic macro-invertebrate community structure.

Urbanisation, arable farming and extent of pasture lands were found to have an impact on the ecological status of rivers and streams. Within the Article 5 risk assessments in RoI and NI, Intensive Land Use was identified as a significant morphological pressure placing waterbodies at risk. This is being further investigated in the Freshwater Morphology POMS Study.

In RoI, the Intensive Land Use analysis within the morphological risk assessment included the following uses:

- Urban fabric and industrial areas

- Peat extraction areas
- Coniferous forests
- Arable land

Similarly in NI, the Intensive Land Use analysis within the morphological risk assessment included:

- Urban
- Improved grassland (pastures)
- Coniferous forests
- Arable land

The main differences in approach between the two jurisdictions were:

- o Commercial peat extraction was included in RoI but not NI where the activity does not occur;
- o Improved grassland was included in RoI but not NI.

However, both Intensive Land Use risk assessments proved to be significant in placing waterbodies at risk.

Applicability to Freshwater Morphology Study:
The specific land uses assessed in Article 5 are in keeping with the findings of the TCD Study (Document 6.2) i.e. urbanisation, arable farming and extent of pasture lands. This provides verification to the Article 5 risk assessments and reinforces the need for further investigation in the Freshwater Morphology POMS Study.

In the UK, Lancaster University hosted a Freshwater Morphology workshop in June 2006 to discuss WFD research needs **(Document 6.3)**. Delegates from Government Authorities in England and Scotland, consultants and academics were in attendance. RPS Consulting Engineers attended on behalf of the Shannon River Basin District Project. The key research gaps identified were:

- The link between hydromorphological conditions and ecology is not well developed.
- The difficulty in establishing a link between hydromorphology and ecology is not fully appreciated.
- The effect of climate change on ecological quality of aquatic ecosystems is not well researched at present.

Applicability to Freshwater Morphology Study:

The project team will monitor research proposals that emerge from this workshop and review as appropriate.

Documents 6.4 to 6.12
Development of Morphological Assessment Applications for Rivers

Table 6.3 lists the Development of Morphological Assessment Application for Rivers documents that have been reviewed to date.

Table 6.3 Development of Morphological Assessment Applications for Rivers: Documents that have been reviewed to date.

Document Number	Document	Author
6.4	ERTDI Study – Hydromorphology of Rivers – A desk study to determine a methodology for the monitoring of hydromorphological conditions in Irish Rivers for the Water Framework Directive (2002-W-DS/9)	ERTDI – P McGinnity et al
6.5	Feasibility study- remote sensing to assess hydromorphology of surface waters	SEPA
6.6	UK Environmental Standards and Conditions (Phase 1)	UK TAG
6.7	WFD 49(Rivers): A new impact assessment tool to support river engineering regulatory decisions (draft) - MImAS	SNIFFER
6.8	WFD 49(Rivers): A new impact assessment tool to support river engineering regulatory decisions – Short summary and response to project peer review and Field Trialling - MImAS	SNIFFER
6.9	NS SHARE Guidelines for the Assessment of the Hydromorphological Status of Rivers, Part I Principles	Cambridge University
6.10	NS SHARE Guidelines for the Assessment of the Hydromorphological Status of Rivers, Part II Assessment Procedure	Cambridge University
6.11	River Habitat Survey in Britain and Ireland, Field Survey Guidance Manual:2003 Version	EA, SEPA, EHS
6.12	Linking organisms to natural and modified river hydromorphology by the analysis of existing data	Dr Ian Vaughan & Prof. Steve Ormerod, Cardiff University

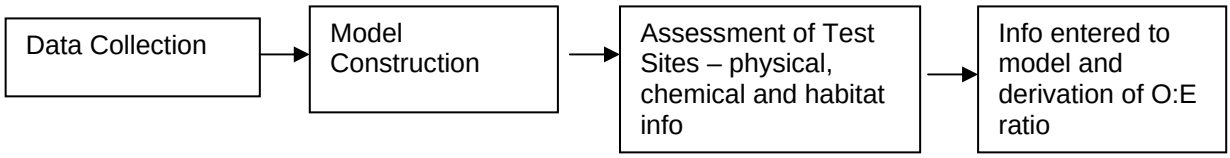
Morphological Assessment Techniques - Initial Research

Document 6.4, *(ERTDI) Study – Hydromorphology of Rivers – A desk study to determine a methodology for the monitoring of hydromorphological conditions in Irish Rivers for the Water Framework Directive (2002-W-DS/9)* was funded by the EPA in 2003 and led by the Central

Fisheries Board. It addressed priority areas necessary for the implementation of WFD in Ireland. The objective was to develop a practical methodology for the assessment of river morphological conditions in Irish rivers, taking account of the guidance from the WFD implementation activities of the European Commission, national expertise and other forms of international best practice. The analysis undertaken included a review of 29 different river morphology (habitat) assessment systems and consultations with Irish practitioners in the field.

Following the review, a physical assessment protocol based on the AusRivas technique used in Australia was recommended. This involves the collection of physical, chemical and habitat information from reference sites which is then used to construct predictive models.

The process is as follows:



The Observed: Expected (O: E) ratio compares the expected features on a site based on reference conditions to those actually observed. This is used to decide on a hydromorphological score for a site.

Figure 4 illustrates the input requirements to the model.

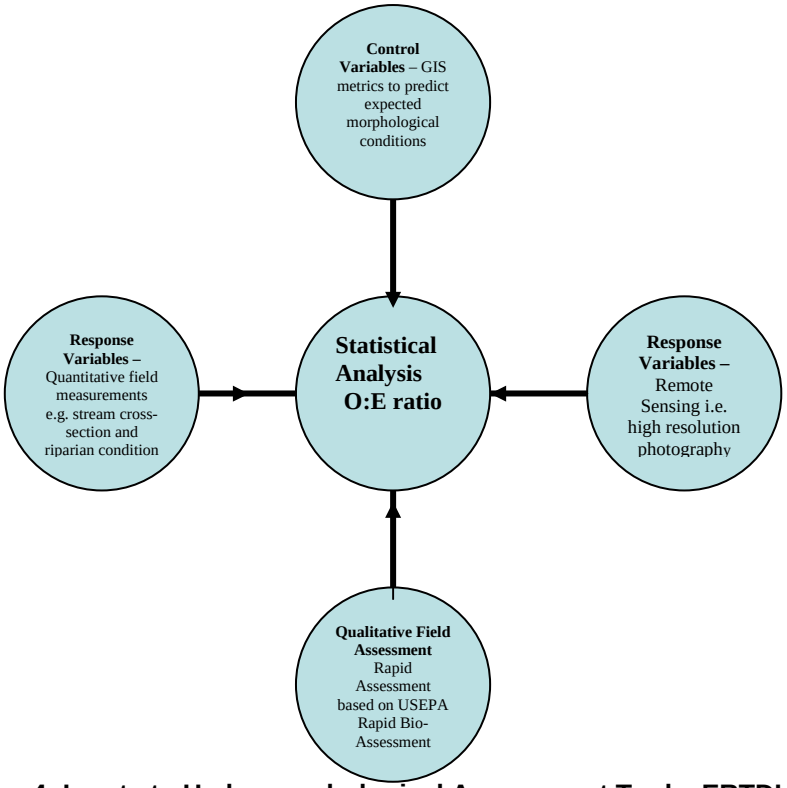


Figure 4: Inputs to Hydromorphological Assessment Tool – ERTDI 2003

A significant recommendation from Document 6.4 was to enhance the morphological assessment tool by utilising modern technology. Remote sensing; use of high resolution aerial photography; and Geographical Information Systems to generate metrics were recommended in this respect.

Applicability to Freshwater Morphology Study:
These recommendations have been incorporated into the Terms of Reference for the Freshwater Morphology POMS Study. It is proposed that fieldwork and aerial photography will be carried out to establish a link between remote sensing and fieldwork so that a more effective method of morphological assessment can be developed. However, it is envisaged that some element of fieldwork will always be necessary as it is recommended by ERTDI that morphological conditions should be observed over time to detect change and to update predictive models/tools.

A research project entitled "*Feasibility study- remote sensing to assess hydromorphology of surface waters"* funded by SNIFFER (**Document 6.5**), looking at the feasibility of using aerial photos and/or satellite imagery for characterisation and provision of consistent data, was undertaken in 2002 by Stirling University. (Refer to http://www.wfduk.org/tag_guidance/Article%20_11)

The study concluded that aerial photography is more cost-effective to use than satellite imagery. UK TAG is taking this forward with a view to creating a dataset of existing hydromorphological conditions. SEPA are using this research as a basis to inform the MImAS decision support tool for hydromorphological assessment. Work is currently underway in Scotland to collate aerial photography so that data on hydromorphological conditions of a waterbody can be input to the tool (refer to Section 8.0)

Applicability to Freshwater Morphology Study:
The use of GIS –based analysis to extract morphological features from aerial photography will be investigated as part of the Study. This is also conducive to informing morphological assessment techniques such as Rapid Assessment Technique or predictive tools such as MImAS

The UK Technical Advisory Group (UKTAG) is developing environmental standards and conditions to underpin implementation of the WFD. An Environmental Standard is an expression of a waterbody's ability to absorb change, or the level at which, if exceeded, will cause deterioration in status. **Document 6.6,** *"UK Environmental Standards and Conditions (Phase 1)*" was published in January 2006. The final version is due for publication by UKTAG in September 2006 and will be included in Literature Review No. 2.

Environmental Standards are used to assist in a decision making framework when developing Programmes of Measures and in regulation of e.g. engineering activities on rivers. The Standards currently being developed for surface waters fall into three groups:

1. **Physico-Chemical** – Numeric values have been developed which have been matched to biology;
2. **Hydrological** – Numeric values supported by modelling have been developed, based upon the best available understanding of links to biology; and
3. **Morphological** – A decision framework using best available knowledge supported by numeric thresholds

A waterbody must meet all of these Environmental Standards in order to be classified as High Status.

To assess water quality new methods are being developed. For example, the RIVPACS method is being built upon to develop a new method to assess the biological quality of a waterbody. Phosphorus Standards for rivers will be set by looking at sites which have Good Status with respect to plant communities (diatoms).

However for morphological standards, there is insufficient data in existence to derive Standards in this way. Instead, an up to date scientific understanding of the causes of ecological changes are used in comparison with the WFD's description of condition of plants and animals in each status class. The understanding of links between ecology and changes in morphology is not well developed. There is no organised method for looking at the requirements of aquatic organisms for their physical habitat.

UKTAG has used a pragmatic approach to develop a decision support framework to help assess the risk to ecological status of a waterbody as a result of proposed alterations to morphology e.g. river engineering activities.

The concepts of the UK TAG decision support framework are:

(1) A waterbody has some capacity to accept morphological change without changing its ecological status

(2) Expert judgement can set acceptable limits for morphological change in conditions beyond which there would be concern about risk to ecological status

The assumptions of the UK TAG decision support framework are:

- There is a relationship between extent of morphological alteration and ecological status
- Response is predictable and depends on the sensitivity of the ecology of the river
- Response is predictable for a type of waterbody

UKTAG recognises that such concepts and assumptions require testing and validation. However, using this basis, Morphological Condition Limits (MCL's) were developed beyond which there would be concern that there is a risk to High or Good Ecological Status. The MCL's for river morphology are presented in Table 6.4 *(Source UKTAG, Environmental Standards and Conditions, Phase 1)*. The MCL's are expressed as a percentage of the "capacity" that has been taken up i.e. a river's capacity to accept morphological change without changing its ecological status.

Table 6.4: UKTAG Proposals for River Morphology – Conditions to Protect Ecological Status

Zone	**% of the capacity used**	
	High Status	**Good Status**
Channel	5	15
Bank and Riparian	5	15

Applicability to Freshwater Morphology Study:

Morphological Condition Limits developed by UKTAG have been applied in the development of morphological assessment tools in the UK. The use of MCL's and any tools that they may inform will be further investigated with a view to possible adaptation and application to RoI and NI.

Documents 6.7 – 6.11
Morphological Assessment Techniques

Figure 5 illustrates the current morphological assessment techniques as listed in Table 6.3. Three techniques currently available for assessing the morphological condition of rivers have been reviewed in this report. However other methods are available internationally (Document 6.4 provides a review of these techniques and recommends that consideration is given to AusRivas physical assessment protocol and the USEPA Rapid Biological Assessment Protocol).

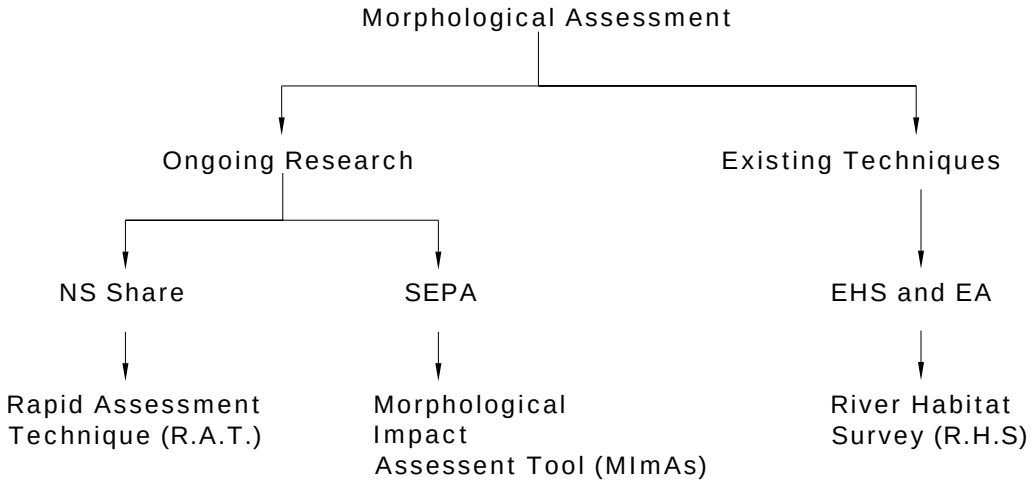


Figure 5: Diagram indicating the Morphological Assessment Tools currently being researched or used.

Within the Freshwater Morphology POMS Study, each technique will be undertaken within a fieldwork study and compared in terms of effectiveness on the field; time taken to complete and results obtained. This will provide data and on the ground experience of the merits of each technique enabling an informed decision to be made on the technique(s) that could be further explored for application in RoI and NI. Each technique is reviewed in the following sections of this report.

Document 6.7

SEPA (SNIFFER) Morphological Assessment Tool - MImAS

SNIFFER sponsored a study (WFD 49 (Rivers)) which developed an impact assessment tool that used the Morphological Condition Limits (Table 6.4) recommended by UK TAG. The

impact assessment tool developed is called the Morphological Impact Assessment Tool (MImAS).

The aim of the WFD49 study was to develop a simple practical decision support framework to determine:

- if a new river engineering activity is likely to result in deterioration of ecological and morphological quality and;
- whether the extent of existing morphological alteration is likely to put a waterbody at risk of failing to meet good ecological status.

At present, there is no agreed way of looking at requirements of aquatic organisms for their physical habitat.

Building on the concepts and assumptions made by UK TAG in developing the Morphological Condition Limits (MCL's) that are used in MImAS, the concepts and assumptions of the MImAS tool are as follows:

The concepts of the MImAS tool are:

(1) A waterbody has some capacity to accept morphological change without changing its ecological status;

(2) Expert judgement can set acceptable limits for morphological change in conditions beyond which there would be concern about risk to ecological status.

The assumptions of the tool are:

- There is a relationship between extent of morphological alteration and ecological status;
- Response is predictable and depends on the sensitivity of the ecology of the river;
- Response is predictable for a type of waterbody;
- The tool will not reduce the requirement for site investigations or expert advice;
- The tool is intended to sit within a larger decision making framework that promotes balanced regulatory decisions;
- Rivers will be managed to ensure the attainment/protection of the following WFD objectives;
- High status: Morphological quality will be protected to ensure minimal human alteration;
- Good status: Morphological quality will be protected as far as is consistent with the achievement of good status biology;

- Moderate status or less: Morphological quality will be protected to avoid deterioration in biological quality and to ensure future restoration potential
- HMWB and AWB are not considered;
- Work is part of a wider UKTAG work programme that was tasked with developing new tools to support implementation of WFD and associated UK law;
- Team of external experts provide input on the following aspects:
  - Peer review
  - Technical guidance in key project junctures
  - Final peer review of proposed morphological condition limits
  - A steering group was also set up to co-ordinate the project and ensure links to other UKTAG Projects.

The MImAS tool provides a basis for making simple consistent decisions on likely impacts of engineering activities and risk of failing to achieve good ecological status. It has 5 modules as presented in Figure 6.

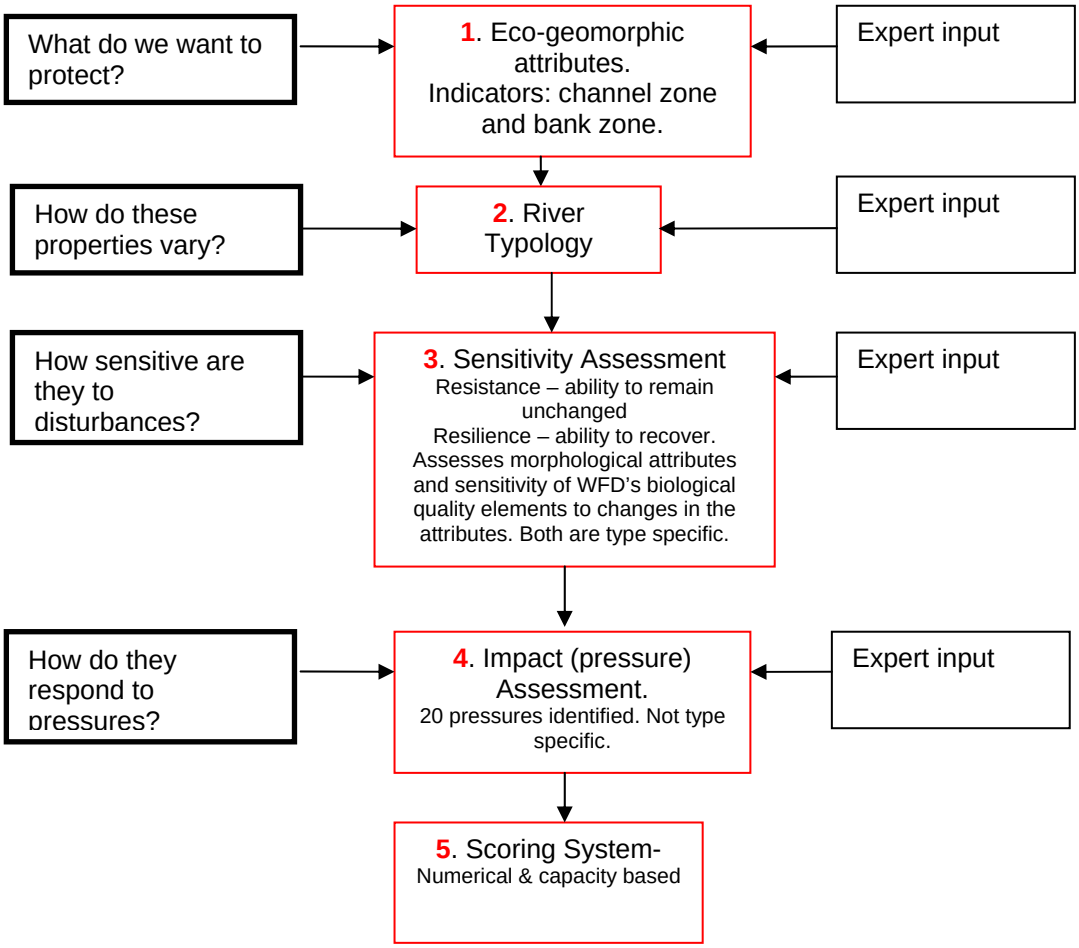


Figure 6: Modules of the MImAS Tool

'Single activity limits' are defined as how much of a single activity will risk causing a 500 m channel to degrade from *high* to *good* or *good to less than good* status (and by extension to *moderate*, *poor* and *bad*). These limits are contained within a look up table to enable quick decisions on straightforward cases.

The user can also input footprints for different engineering activities to the tool. It determines the amount of capacity of the waterbody to accept morphological change

Channel Zone and Bank Zone Attributes

The eco-geomorphic attributes used in MImAS are summarised in Table 6.5 (*extract from Document 6.7*). These are defined as channel zone and bank zone attributes. The attributes used in the NS Share tool (Rapid Assessment Technique), as discussed later in this report, also use channel zone and bank zone distinctions. It is considered in both models, that these attributes sustain an ecologically sound riverine eco-system.

Eco-geomorphic attributes	Definition
Channel zone	
Hydraulic geometry	*Describes the size and shape of the channel*
Planform	Spatial pattern and location of a channel, as viewed from above
Cross section	The cross sectional form of the channel (width-depth)
Profile (Slope)	Slope of the channel bed and the variation of that slope
Substrate condition	*Describes the size, structure and sorting of riverbed gravels*
Substrate size	The size distribution of surface gravels
Embeddedness	The extent to which framework gravels are covered or sunken into the silt, sand, or mud of the riverbed.
Compaction	A measure of the degree of sediment imbrication and, potential mobility under normal flow conditions
Erosion/deposition character	*Describes trends in sediment, mobilization, transport and deposition*
Lateral rate of adjustment	The extent and rate at which a channel can move in the river corridor
Bar character	Size, distribution and stability of natural deposition features.
Bedform pattern	Topography of the riverbed and bed features.
In-channel vegetation	*Describes the presence and distribution of vegetation features*
Structure and extent of instream vegetation	The character and density of aquatic and terrestrial vegetation,
Structure and extent of Woody debris	The character and density of large woody debris, linked to geomorphic structure and flow patterns
Longitudinal connectivity	*Assess artificial barriers to flow, sediment and migratory movement*
Migratory movement	Ability of aquatic organisms to migrate freely through the channel
Sediment transport	The transport capacity of the channel. A measure of the competency of a channel to transport sediment.
Banks and Riparian zone	
Bank morphology	The shape and character of the bank and presence of erosion features
Riparian vegetation structure	The character and density of vegetation, linked to geomorphic structure and flow patterns.
Bank roughness	The roughness of the channel banks (includes consideration of materials and presence of vegetation).
Floodplain extent	Size of floodplain perpendicular to the channel
Floodplain vegetation structure	The character and density of vegetation, linked to geomorphic structure and flow patterns
Floodplain connectivity	Ability of the channel to flood the adjacent land

Table 6.5: Eco-geomorphic attributes used in the MImAS Tool (WFD 49)

MImAS Morphological Impact (Pressure) Assessment

Engineering activities can affect channels in various ways which in turn, can affect multiple channel attributes**.** Impacts often extend beyond the zone of activity, typically in a downstream direction**.** The Impact assessment determines the likelihood that an activity will

impact on the eco-geomorphic indicators, and a simple assessment of the likely extent of impact. Twenty generic engineering activities are listed in the tool.

MImAS Scoring System

The Scoring System uses capacity thresholds which are developed based on the outputs of the development of environmental standards as presented in "UK Environmental Standards and Conditions (Phase 1)" (Document 6.6) and Table 6.4 of this report.

Capacity thresholds are expressed in percentage terms as a "capacity" used. If a development lies beyond the MCL's a more detailed assessment is required.

The amount of capacity used by a pressure in a given type is based on the following equations:

Capacity Used = Activity Impact Score x Activity Footprint

where

Activity Impact Score = Ecological Sensitivity x Morphological Sensitivity x Likelihood of Impact x Zone of Impact

The Activity Impact Score is calculated for each attribute in turn, and then averaged for attributes within zones. This gives a score for each activity or pressure within each zone.

Document 6.8

WFD49 MImAS Peer Review and Field Trialling

Assessment of the Morphological Condition Limits and the MImAS tool was undertaken by comparing outputs from the tool with professional judgement of the morphological/ecological status of ninety 500m river reaches with status values ranging from High to Bad.

River engineering footprint activities included bank protection, weirs and culverts, dredging and gravel extraction, channel realignment and embanking.

The report concluded that MImAS appears to be an effective risk based assessment tool for assessing the impact of river engineering activities along 500m stretches. Continued data collection to inform a rolling programme of model evaluation was recommended perhaps in line with River Basin Management Plan (RBMP) cycles.

Future requirements for developing the MImAS tool are:

- Creation of a scoring system for rivers with significantly modified hydrological and sediment regimes due to catchment wide activities

- Up-scaling of results to 10km stretches allowing decisions to be made at a waterbody scale.

Using MImAS as a Regulatory Tool

SEPA's intended use of the MImAS Tool is summarised as follows:

- For assessing new and existing river engineering activities
- To identify proposals that would potentially put ecological status at risk
- Identifying proposals that could be subject to a more detailed assessment which would consider wider flood management objectives and socio-economic concerns

A regulatory decision making process within Government Authorities can incorporate MImAS as a way of complying with WFD requirements. For example, Scotland has developed the Controlled Activities Regulations (C.A.R.) to regulate a range of river activities including engineering works and water abstraction. A generic decision making process incorporating MImAS is as follows:

1. Has **Best Practice** been employed?

2. **Does the proposed activity risk WFD objectives? – MImAS tool could assist here to determine if there is a need for further investigation?**

3. Does activity meet flood management objectives?

4. If application fails basic criteria – Is it eligible for exemption based on over-riding socio-economic considerations?

(Source: WFD 49(Rivers): A new impact assessment tool to support river engineering regulatory decisions (draft))

Using MImAS as a Classification Tool

Dr Stuart Greig (SEPA), a member of the Project Team for the WFD49 study which produced MImAS, gave a presentation on the tool at the Freshwater Morphology Workshop in Lancaster in June 2006. Within this presentation it was indicated that there is a proposal to use MImAS to classify for morphology within the WFD. Ecological classification tools currently under development are macro-invertebrates; macrophytes and fish. However, there are concerns about the use of ecological tools to assess morphological conditions given the lack of scientific knowledge about the link between morphology and ecology in aquatic eco-systems.

Documents 6.9 and 6.10

NS SHARE Morphological Assessment Tool – Rapid Assessment Technique (R.A.T)

Work has been undertaken through the NS SHARE project to develop a methodology for assessing hydromorphological status of waterbodies. Two reports (Documents 6.9 and 6.10) have been submitted to the NS SHARE Project by Dr Keith Richards and Rachel Horn from Cambridge University in draft format (September 2005). Part I discussed the principles behind the guidelines for assessment. Part II detailed the assessment methodology.

The assessment methodology involves a semi-quantitative rapid assessment technique of sites supported by the use of map and aerial photography (remote sensing) to allow measurement of parameters from a desk study where possible. The measurement of deviation from reference state is the principle indicator of status, with allowances for spatial variability i.e. river typology.

It is based on six types and requires consideration of a matrix of eight ecologically-relevant river attributes i.e.

1. Channel Morphology and Flow Types
2. Channel vegetation
3. Substrate diversity and condition (embeddedness)
4. Channel flow status (low flow conditions)
5. Bank structure and stability
6. Bank vegetation
7. Riparian land use
8. Floodplain – channel lateral connectivity

Attributes and their relevance to biological quality elements are described along with details of how an assessment is made. Assessment Guidance Sheets for field use have been designed, giving a brief description of the aim of the attribute, typical condition categories for each score, the undisturbed state for each stream type, a short list of pressures that may affect the attribute for a particular stream type, and broad outlines of the departure from high status under the influence of pressures.

Once a specific reach to be assessed has been selected using a map of the drainage network, an initial GIS-and aerial photography-based desk study is to be used to identify the expected stream type according to defined criteria. A range of reach and catchment scale information is also recorded.

Field Assessment Sheets have been designed to enable rapid assessment of the hydromorphological attributes of a stream. In order to produce a rapid assessment methodology which can be applied to the range of rivers and streams present in Ireland, a general description of the conditions expected for a range of stream types have been included in these sheets along with scoring details. Assessment is supported by photographs showing both reference conditions for each generic stream type and the effects of disturbance on a range of attributes for a range of stream types.

The assessment has been presented in a series of steps as a decision making process:

1. Design of a sampling programme for waterbodies and reaches
2. Definition of river typology for each waterbody
3. Assessment of group of semi- quantitative attributes to measure proximity of each river reach to the reference state for its type.
4. Overall assessment of waterbody status – a "Hydromorph score" is assigned based on cumulative scoring of attributes as a percentage of the attributes score for the reference condition.

$$\text{"Hydromorph score"} = \frac{\Sigma \text{ Assessment scores}}{\text{Maximum possible score (reference conditions)}}$$

WFD Class:

> 0.8 = high status

0.6 – 0.8 = good status

0.4 – 0.6 = moderate status

0.2 - 0.4 = poor status

< 0.2 = bad status

Applicability to Freshwater Morphology Study:

Within the fieldwork package of the Freshwater Morphology POMS Study (Work Package 4), an objective has been developed to assess the NS Share R.A.T and the SEPA MImAS tool in terms of the applicability to both classification and regulation in RoI and NI. The work will involve the undertaking of the field surveys associated with each tool and comparing them in terms of time taken to complete and the results obtained. This will provide an indication of the most applicable tool to Irish rivers and can inform a larger scale fieldwork programme within the Freshwater Morphology POMS Study in 2007.

Document 6.11

River Habitat Survey

Extracts from the River Habitat Survey, Field Survey Guidance Manual: 2003 Version are presented as follows.

"River Habitat Survey (RHS) is a method designed to characterise and assess, in broad terms, the physical structure of freshwater streams and rivers. The field survey element does not require specialist geo-morphological or botanical expertise, but recognition of vegetation types and an understanding of basic geo-morphological principles and processes are needed.

RHS is carried out along a standard 500m length of river channel. Observations are made at ten equally spaced spot-checks along the channel, whilst information on valley form and land-use in the river corridor provides additional context. Based on the field assessment results of each attribute in the channel, bank and riparian zone, a Habitat Modification Score (HMS) is calculated. This encompasses the scores attributed on the field survey sheet for the following observations and provides a numeric representation of the degree of modification of a river.

- Reinforcement to banks
- Reinforcement to bed
- Re-sectioned bank or bed
- Two-stage bank modifications
- Embankment
- Culverts
- Dam, weir, ford
- Bank poached by livestock

The RHS database contains field observations, map-derived information and photographs from more than 4600 RHS baseline survey sites visited in 1994-96 and over 12,000 subsequent surveys. Since then, surveys have been used for a number of purposes, including: determining the catchment characteristics of several rivers in the UK; identifying the attributes of known top quality 'benchmark' sites; investigating possible species–habitat relationships; and providing input to environmental impact assessments.

RHS has also been tested in other European countries such as Finland, France, Austria, Portugal (Madeira), Italy and Slovenia with a view to adapting the survey for local conditions. Cross-comparison between RHS and other methods for surveying river hydromorphology in Europe has also been carried out, with a view to producing standard guidance on techniques for assessing the physical characteristics of watercourses.

The WFD has had a major influence in the development of RHS. The prototype of the survey was developed in anticipation of the requirements of such a Directive as long ago as 1992. RHS can provide consistent framework within which aquatic macro-invertebrate, macrophyte, fish and geo-morphological surveys can be set.

The field survey has been designed, tested and improved as a result of extensive use on rivers in the UK since 1994. The 2003 version represents the first major overhaul of the form design, revision of some component elements and updating of the guidance manual, since 1997. Improvements in the contents and design of the form and the supporting guidance have been necessary to remedy weaknesses in the consistency of recording.

Applicability to Freshwater Morphology Study:
Within the Freshwater Morphology POMS Study (Work Package 4) it is proposed to test the RHS against the NS Share R.A.T and the SEPA MImAS Tool to compare the results obtained. This will provide an estimate of the HMS which will enable comparison with the "Hydromorph Score" derived using the NS SHARE R.A.T and the MImAS tool "Capacity Used" score.

Document 6.12

Morphological Assessment – Proposed Research

Academics from Cardiff University have proposed to undertake a research project with a primary objective of improving the understanding the links between riverine ecology and hydromorphology, "*Linking organisms to natural and modified river hydromorphology by the analysis of existing data*". It is recognised that this is vital to delivering the WFD.

The proposal states that the needs of the regulatory and conservation agencies in terms of morphological regulation and classification are not backed up by solid scientific research at present. It suggests that this could carry risks for water management. The proposal involves the analysis of existing data collected by the regulatory agencies, with a view to advancing ecology-hydromorphology links. The basic approach is to relate the distributions of a wide range of organisms to hydromorphology in a large sample of river sites with semi-natural or modified channels. Primarily, the RHS database is suggested as it is the only hydromorphic dataset with detailed UK-wide coverage. It is proposed to use this in conjunction with large biological data sets (e.g. BIOSYS).

A key aim is to develop the evidence base for managing and regulating hydromorphological modifications and pressures. This should have widespread applications to management and research across the UK.

In particular it is proposed that analyses tailored to supporting or augmenting specific management tools, such as MImAS (refer to Section 7.0) will be undertaken. The evidence base generated by this work will be passed onto the agencies in regular, detailed reports which explain the implications for existing and future management of hydromorphology. Several peer-reviewed publications are also anticipated, as are short papers recommending future research priorities.

Cardiff University consider these analyses as a "first step in providing support for existing management, guiding the development of new management tools and helping to inform research strategies. In the medium to longer term, dedicated research aimed at understanding the *mechanisms* linking organisms and hydromorphology is essential for sustainable river management e.g. devising Programmes of Measures".

This project proposal is currently being considered by UKTAG. If approved, the expected timescale is two years.

Applicability to Freshwater Morphology Study:

The outputs of this study have significant relevance to the Freshwater Morphology POMS Study. More specifically, the evidence presented and the analyses in support of management tools such as MImAS provides valuable input and information on the viability of decision support tools for regulators. The phased deliverables of this project will be closely monitored as the Freshwater Morphology POMS Study progresses.

Documents 6.13 – 6.16

Development of Morphological Assessment Applications for Lakes

Development of a tool for classifying the status of lakes is important in the context of implementing the WFD. It will be expected to define the physical attributes of water bodies at High Ecological Status (HES); investigate possible reasons for water bodies failing to achieve Good Ecological Status (GES) and characterise and putting in place appropriate monitoring of heavily modified water bodies (HMWBs) and artificial water bodies (AWBs). Table 6.6 lists the Development of Morphological Assessment Applications for Lakes Documents that have been reviewed to date.

Table 6.6 Development of Morphological Assessment Applications for Lakes: Documents that have been reviewed to date.

Document Number	Document	Author
6.13	WFD42 - Development of a Technique for Lake Habitat Survey (LHS)	SNIFFER
6.14	WFD49a - Development of Decision Making Frameworks for Managing Alterations to the Morphology of Lakes	SNIFFER
6.15	WFD49a – Proposed Extension and Further Development	SNIFFER
6.16	The development of a methodology for collecting hydromorphology data in lakes (Parts 1,2 & 3)	Bob Duck for NS SHARE

Document 6.13 (WFD 42) entitled "Development of a Technique for Lake Habitat Survey (LHS): Phase 2" has produced a method for surveying and recording the morphological characteristics of lakes. The survey method was also designed to assess habitat quality of lakes.

The summary metric, the Lake Habitat Modification Score (LHMS), uses a set of 6 pressures with a range of 5 scores, graded by intensity, to classify lake modification.

This project alone was unable to develop LHS with the ability to make a sufficiently strong link between morphological characteristics and the ecology of the lakes. This was mainly due to a lack of corresponding ecological data to refine the scoring system.

Document 6.14 (WFD 49a), "Development of Decision Making Frameworks for Managing Alterations to the Morphology of Lakes" also produced a summary metric, known as the Alteration of Lake Morphology Score (ALMS). This metric relies to a large extent on information obtained through LHS, but can also be used in conjunction with aerial

photographs and maps. It looks at 12 pressures, each graded by 3 intensities, to classify the amount that each lake has been modified. The presence of bridges, causeways, fish cages, dredging, dumping, macrophyte control, and damage to the shore area through recreational use contribute to the ALMS. The pressures that are recorded by LHS but not used in ALMS are boat use, swimming, angling, fish stocking, power lines, liming, odour and surface films.

Document 6.15 is an extension to WFD 49a to further develop the ALMS tool and is being sponsored by UK TAG. The work includes peer review and field trialling on a number of lakes to compare the results with expert judgement. This work commenced in September 2006 and is similar to the process undertaken in developing a morphological assessment tool for rivers.

Assessment of the ALMS approach and its application to defining WFD lake classification boundaries for morphology would also be undertaken. This work would encompass the development of a GIS based lake sensitivity typology and a review of data requirements to apply the ALMS system. This is due for completion in April 2007. Following on from this work, the ALMS approach for lakes will be streamlined with the MImAS approach for rivers and implemented.

Building on the output from WFD 42 and 49a the objective of this extension project is to produce a tool for classification of lake morphology in the UK both in relation to existing levels of pressures and impacts and with respect to new development proposals.

Document 6.16 comprises 3 parts and was commissioned through the NS SHARE project with a view to developing a methodology for collecting hydromorphology data in lakes. The recommendations of this report mirrored the approach in the UK, by suggesting that the revised form of LHS i.e. ALMS could be used in NS SHARE lakes, but that developments in the UK with respect to LHS and its associated scoring method as per Documents 6.14 to 6.16 should be monitored to ensure a co-ordinated approach in NI and RoI.

Applicability to Freshwater Morphology Study:
Within the Freshwater Morphology POMS study, developments with respect to morphology assessment tools for lakes within the UK will be monitored and reported on with a view to possible adaptation and application in RoI.

7.0 Conclusion – Key Applications of Literature Review 1 to Freshwater Morphology POMS Study

This report provides a comprehensive review of literature documents relating to Freshwater Morphology as of September 2006.

The discussion of **Guidance Documents** in Chapter 5.0 places the work undertaken at the Article 5 Characterisation stage of WFD implementation, particularly with respect to Freshwater Morphology Risk Assessment, into context. The uncertainties associated with the risk assessment and the differences in approach taken between RoI and NI identifies the need for closer investigation into freshwater morphology within the Further Characterisation phase of WFD implementation in Ireland.

The discussion of **Research and Development of Morphological Assessment Applications** Documents in Chapter 6.0 draws out their key points and identifies how they are applied to ongoing work packages within the Shannon RBD Freshwater Morphology POMS Study. The applications highlighted in Chapter 6.0 are summarised as follows:

Document Group: Past Research

Document Number	Document Name	Year Published	Applicability to Freshwater Morphology POMS Study
6.1	*ERTDI- Water Framework Directive Characterisation of Ref Conditions and Testing Typology of Rivers (50 refcon sites)*	2002	The morphological alterations and reference condition status identified at specified sites within Document 6.1 resulted in their selection for inclusion in the fieldwork aspect of the Freshwater Morphology POMS Study. It is considered that any morphological impact on these sites can easily be isolated and attributed to morphological alterations, as pressures such as point source pollution or abstraction are not present. In addition, their reference condition would provide a benchmark for comparison with other sites of the same typology
6.2	*Ian Donohue et al - Linking Catchment Characteristics and Water Chemistry with the Ecological Status of Irish Rivers*	2006	The specific land uses assessed in the Article 5 Morphological Risk Assessment are in keeping with the findings of the Document 6.2 i.e. urbanisation, arable farming and extent of pasture lands. This provides verification to the Article 5 risk assessments and reinforces the need for further investigation in the Freshwater Morphology POMS Study.
6.3	*Freshwater Morphology Workshop – Research Needs, Lancaster University*	May 2006	The project team will monitor research proposals that emerge from this workshop and review as appropriate.

Document Group: Development of Morphological Assessment Applications for Rivers

Document Number	Document Name	Year Published	Applicability to Freshwater Morphology POMS Study
6.4	*ERTDI Study – Hydromorphology of Rivers – A desk study to determine a methodology for the monitoring of hydromorphological conditions in Irish Rivers for the Water Framework Directive (2002-W-DS/9)*	2002	The recommendations made from this desk study have been incorporated into the Terms of Reference for the Freshwater Morphology POMS Study. It is proposed that fieldwork and aerial photography will be carried out to establish a link between remote sensing and fieldwork so that a more effective method of morphological assessment can be developed. However, it is envisaged that some element of fieldwork will always be necessary as it is recommended by ERTDI that morphological conditions should be observed over time to detect change and to update predictive models/tools.
6.5	*SNIFFER -Feasibility study – remote sensing to assess hydromorphology of surface waters*	2002	The use of GIS –based analysis to extract morphological features from aerial photography will be investigated as part of the Freshwater Morphology POMS Study. This is also conducive to informing morphological assessment techniques such as the pressure based Rapid Assessment Technique or predictive tools such as MImAS.
6.6	*UK TAG - UK environmental Standards and conditions (Phase 1)*	Jan 2006	Morphological Condition Limits (MCL's) developed by UKTAG have been applied in the development of morphological assessment tools in the UK. The use of MCL's and any tools that they may inform will be further investigated with a view to possible adaptation and application to RoI and NI.
6.7	*SNIFFER - WFD 49 (rivers) A new impact assessment to support engineering regulatory decisions – Sort summary and responses to project peer review and Field trialing – MImAS*	2006	Within the fieldwork package of the Freshwater Morphology POMS Study (Work Packages 4 & 5), an objective has been developed to assess the NS Share R.A.T and the SNIFFER/SEPA MImAS tool in terms of the applicability to both classification and regulation in RoI and NI. The work will involve the undertaking of the field surveys

6.8	*SNIFFER - WFD 49(rivers): Anew impact assessment tool to support river engineering regulatory decisions (draft) – MImAS*	Draft 2006	associated with each tool and comparing them in terms of time taken to complete and the results obtained. This will provide an indication of the most applicable tool to Irish rivers and can inform a larger scale fieldwork programme within the Freshwater Morphology POMS Study in 2007. (as above)
6.9	*NS SHARE Guidelines for the assessment of the hydromorphological Status of Rivers, Part I Principles*	Draft 2005	
6.10	*NS SHARE Guidelines for the assessment of the hydromorphological Status of Rivers, Part II Assessment Procedures*	Draft 2005	
6.11	*River Habitat Survey in Britain and Ireland, Field Survey Guidance Manual 2003 version*	2003	Within the Freshwater Morphology POMS Study (Work Package 4&5) it is proposed to test the RHS against the NS Share R.A.T and the MImAS Tool to compare the results obtained. This will provide an estimate of the HMS which will enable comparison with the "Hydromorph Score" derived using the NS SHARE R.A.T and the MImAS tool "Capacity Used" score.
6.12	*Cardiff University - Linking organisms to natural and modified river hydromorphology by the analysis of existing data*	Proposal, 2006	The outputs of this study have significant relevance to the Freshwater Morphology POMS Study. More specifically, the evidence presented and the analyses in support of management tools such as MImAS provides valuable input and information on the viability of decision support tools for regulators. The phased deliverables of this project will be closely monitored as the Freshwater Morphology POMS Study progresses.

Document Group: Development of morphological assessment applications for Lakes

Document Number	Document Name	Year Published	Applicability to Freshwater Morphology POMS Study
6.13	*WFD42 – Development of a technique for Lake Habitat Survey (LHS)*	2006	Within the Freshwater Morphology POMS study, developments with respect to morphology assessment tools for lakes within the UK will be monitored and reported on with a view to possible adaptation and application in RoI.
6.14	*WFD49a – Development of Decisions Making Frameworks for Managing Alternations to the Morphology of Lakes*	2006	
6.15	*WFD49a – proposed extension and Further Development*	Ongoing	
6.16	*The development of a methodology for collecting hydromorphology data in lakes (Parts 1,2 & 3)*	Draft, 2005	

Appendix 1

Documents Reviewed - Summaries

Document 5.1

Pressure and Impacts Analysis – Policy Summary (IMPRESS) (2002)

Common Implementation Strategy

This document acted as guidance on the Pressures and Impacts analysis (Article 5) of the risks resulting from human activity to achieving the objectives of the Water Framework Directive. The principle aim is to identify where and to what extent human activities may be placing the achievement of the directive's environmental objectives at risk.

The report stated that the pressures and impacts analysis must identify significant pressures and those water bodies that are at risk of failing to achieve the Water Directive environmental objectives. They should be proportionate to the difficulty of the assessment, make best use of the existing monitoring data and recognise and record their uncertainties.

Document 5.2
EHS P&I Task 4.1 - Water Quality Impact from Morphological Changes – risk assessment methodology (2004)

Environment and Heritage Service

This document was produced by Environment and Heritage Service to record the methods used in carrying out the Article 5 Pressures and Impacts Analyses with respect to morphological changes in Northern Ireland's waterbodies

Document 5.3
Morphological Risk Assessment – Guidance on thresholds and methodology to be applied in Ireland's River Basin Districts (2004)

This background document to the Article 5 Characterisation Report summarises the methodology and thresholds applied by each RBD to surface water bodies in predicting the risk of not achieving good status by 2015 due to morphological pressures. Documents produced by the CIS, UKTAG and EHS were reviewed in the development of the methodology described. The methodology applies to water bodies in all surface categories. Assumptions and limitations regarding dataset availability and application of the methodology are itemised.

Specific morphological pressures are listed for each category. Pressures examined are tabulated along with thresholds for the assigning of 1a, 1b, 2a, and 2b risk classes. The methodology allows for risk category adjustment based on data confidence levels. The document includes practitioner's guidance indicating the steps taken and buffers applied during the trial phase of the risk assessment to select attributes and overcome some GIS issues.

Application of this methodology by each RBD led to the results compiled in Tables 3.13 (Rivers), 3.19 (Lakes), 3.25 (Transitional) and 3.26 (Coastal) of the Article 5 Initial Characterisation Report and, subsequently, to two Programme Of Measures and Standards (POMS) studies; The Freshwater Morphology of which this Literature Review is a deliverable and a Marine Morphology study.

Document 5.4
NS SHARE – Comparison of Risk Assessment Methodologies used in Northern Ireland and Republic of Ireland (NS Share R-01-A) (2005)

RPS Consulting Engineers

This report documents the approaches adopted for the Article 5 Pressure and Impacts analyses within the North South Share study area by the competent authorities responsible for the implementation of the Water Framework Directive.

Within the island of Ireland there are three international River Basin Districts: the North Western IRBD, Neagh Bann IRBD and the Shannon IRBD, which cross the border between Northern Ireland (UK) and the Republic of Ireland (RoI). It is therefore essential, under Article 3 of the WFD that the competent authorities in both Member States attempt to harmonise, as far as is possible, the approaches adopted in the implementation of the Directive.

This report assessed the methodologies employed in NI and RoI and documented any differences in the risks assessments.

The main differences in approach to the freshwater morphology risk assessment were as follows:
NI – River Habitat Surveys (RHS) were used to determine the impact on morphology of rivers and supplemented by national datasets and land use information where RHS data was not available. Also, NI employed a manual screening risk assessment method.

RoI – RHS data is not available in RoI so national datasets and land use information was used throughout. RoI employed an automated GIS method to assign risk.

Document 5.5
WFD and Hydromorphology, European Workshop, Prague, Workshop Summary Report (2005)

E Kampa & N Kranz

The EC presented a draft mandate for a Common Implementation Strategy (CIS) activity on hydromorphology at a workshop in Prague held in October 2005. The topics discussed were:

- Technical
- Risk Assessment criteria
- Identifying HMWB
- Migration measures compatible with hydropower
- Migration measures compatible with navigation
- Migration measures compatible with range of activities including flood defence

Objectives of the proposed CIS activity discussed at the workshop are:

1. To identify and share good practice approaches to managing the adverse impacts of water issues on the hydromorphological characteristics of surface waterbodies.

2. To identify common criteria for the hydromorphological condition considered necessary to achieve good status and mitigation measures for good ecological potential.

The expected outcome is a technical document comprising of the following main sections:
a) ~ Hydromorphology conditions supporting achievement of good status
~ Case study
~ Emerging common principles and criteria

b) ~ Mitigation measures for achieving good ecological potential
~ Mitigation Measures relevant to existing modifications
~ Mitigation measures relevant to proposed modifications to physical characteristics of surface waterbodies.

Germany and the UK are leading this CIS activity and a steering group will assist the leaders. Workshops involving member states will be organised into two activities – technical and policy integration.

Document 6.1
Environmental Research Technical Development and Innovation Programme (ERTDI)- Water Framework Directive Characterisation of Ref Conditions and Testing Typology of Rivers (50 reference condition sites) (2002)

Mary Kelly-Quinn et al

This study had 2 objectives:

1. To validate reference sites chosen from Q values using all bio indicators identified in WFD, not just macroinvertebrates, and
2. To develop a river typology system (12 identified) and ascertain where reference sites fell into these types.

Fifty potential reference sites throughout RoI, based on Q ratings, were selected by the EPA for macro-invertebrate, phytobenthos and macrophytes surveys. Two stretches were surveyed at each site, each of which was also visually assessed for reference conditions based on their hydromorphology.

Table 3.10 within Document 6.1 lists those sites that exhibited minor impacts which caused deviation from reference condition. Five of these sites deviated from reference condition due to morphological alterations, despite being categorised as high quality in terms of macroinvertebrates. These sites have been included on the list of pilot waterbodies for Freshwater Morphology fieldwork.

Document 6.2
Linking Catchment Characteristics and Water Chemistry with the Ecological Status of Irish Rivers (2006)

Ian Donohue et al

The aim of this study was to achieve a quantitative understanding of linkages among catchment attributes, water chemistry and the ecological status of aquatic ecosystems.

Analysis of ecological status as indicated by biotic index was based on benthic macro invertebrates community structure.

797 hydrologically independent river sites were studied with the following conclusions made:

- There is an inverse relationship between:
    - Ecological status of rivers and measures of catchment urbanisation and Agricultural intensity
    - Density of humans and cattle and chemical indicators of water quality
    - Urbanisation, arable farming and extent of pasture lands impact on the ecological status of streams and rivers
- More careful land use planning in Ireland is needed.

Urbanisation, arable farming and extent of pasture lands are the principal pressures at catchment scale that impact on ecological quality of streams and rivers in Ireland.

Simple models can predict the likelihood of risk of failure using widely available landcover data or chemical monitoring data. These have the potential to be of use in risk management and as a planning tool in catchments.

Results suggest that if current land uses are unchanged, it will be difficult to meet demands of WFD.

Document 6.3
Freshwater Morphology Workshop – Research Needs, Lancaster University (May 2006)

This workshop was organised by Lancaster University to provide a forum at which academics and researchers could discuss future research needs within the area of freshwater hydromorphology and the WFD.

Key points from the workshop:

- The difficulty in establishing a link between hydromorph and ecology is not fully appreciated. There is a large gap between geo-morph characteristics and WFD ecological indicators.

- Key areas where our current understanding is weak include
    - Climate change
    - Diffuse pollution
    - Proving and improving ecological validity of MImAS i.e. is the typology ecologically relevant? Are the Environmental Standards relevant? Are the eco-geomorphic attributes relevant?
    - Best Practice Measures for capital works, maintenance and operations and other engineering activities
    - Catchment scale controls on water and sediment dynamics.

- Summary of ongoing and proposed research projects.
    - Quantitative analysis of links between RHS and riverine organisms
    - River Habitats and Sediments Projects (HR Wallingford)
    - EA are in year 2 of 3 year monitoring programme which is of importance in development of POMS.

Document 6.4
ERTDI Study – Hydromorphology of Rivers – A desk study to determine a methodology for the monitoring of hydromorphological conditions in Irish Rivers for the Water Framework Directive (2002-W-DS/9) (2002)

ERTDI – P McGinnity et al

This project on the hydromorphology of rivers was a desk study to determine a monitoring methodology for this aspect of the WFD. The draft report (McGinnity et al., 2004) proposed a methodology similar to the AUSRIVAS technique used in Australia that is based on a tiered hierarchical structure with control variables, operating at a catchment level, which in turn influence response variables, operating at a reach/segment level. It is proposed that control variables would be generated through GIS and utilising a customised hydromorphology toolbox, with remote sensing and high resolution digital photography used to deliver many of the response variable data. The response variables also require measurement in the field to ground truth the aerial imagery, to provide quantitative data and to populate the data models.

Document 6.5
Feasibility study- remote sensing to assess hydromorphology of surface waters (2002)

SNIFFER

This feasibility study concluded that aerial photography is more cost-effective to use than satellite imagery. UK TAG is taking this forward with a view to creating a dataset of existing hydromorphological conditions. SEPA are using this research as a basis to inform the MImAS decision support tool for hydromorphological assessment. Work is currently underway in Scotland to collate aerial photography and pressure datasets so that data on hydromorphological conditions of a waterbody can be input to the MImAS tool

Document 6.6
UK Environmental Standards and Conditions (Phase 1) – Draft, (January 2006)

UK TAG

Understanding of links between ecology and changes in morphology is not well developed. When the WFD was introduced, there was no organised way of looking at the requirements of aquatic organisms in terms of their physical habitats in the UK, and in general across Member States. Furthermore there were no standards or conditions for assessing impact on morphology of engineering and other pressures. Any regulatory decisions that have been made to date have been based on expert judgement.

This document was produced to report on the development of a decision support framework to help assess risk to ecological status from man made alterations to morphology.

The work behind the production of this document comprised developing environmental standards and conditions to underpin implementation of WFD. This includes Morphological Condition Limits (MCL's) for a waterbody, beyond which there would be concern that its ecological status is at risk of deterioration.

The document states that achievements of relevant environmental standards such as MCL's will be taken into account, along with results of biological monitoring, in deciding the status class of a waterbody. All environmental standards (water quality, water levels and MCL's) must be met for a waterbody to be classified as high status.

The existence of a MCL does not mean that an engineering activity will be permitted right up until the point that the limit is reached. The concepts upon which the MCL's are based are:

1) A waterbody can accommodate some morphological charge without changing its ecological status
2) Expert judgement can set limits on morphological conditions
3) The morphological response of a waterbody to any given pressures depends on its morphological type

There are three main assumptions:

1) There is a relationship between the extent of morphology alteration and impact on ecological status.
2) Response of a waterbodys' morphology to an engineering pressure is predictable for the type of waterbody
3) Response of ecology to morphology change depends on sensitivity of ecology of river

MCL's are expressed as % of "capacity" to accept morphological change that is taken up.

River Zone	**Capacity Used**	
	High – Good Status	**Good – Moderate Status**
Channel	5%	15%

Bank and Riparian	5%	15%

These MCL'S have been used in the development of the Morphological Impact Assessment Tool (MImAS) which is currently being used by the Scottish Environmental Protection Agency within their Controlled Activities Regulations for engineering activities on rivers (Documents 6.7 and 6.8).

Document 6.7

WFD 49(Rivers): A new impact assessment tool to support river engineering regulatory decisions (draft) – MImAS (2006)

SNIFFER

Following on from the UK TAG development of MCL's, SNIFFER commissioned a project to develop a new impact assessment tool to support river engineering regulatory decisions based on these standards. The tool developed is called Morphological Impact Assessment Technique (MImAS) and is also being used for classification purposed by SEPA at present.

MImAS comprises five modules (attributes, typology, sensitivity, pressure and scoring) which together are used to assess how much 'capacity' is used up by individual pressures or combinations of pressures (WFD49, 2006). MCL's thus define permissible levels of impact on a system's available capacity consistent with WFD status objectives.

The scheme depends on a relatively small number of activities (pressures), most of which can be quantified from maps and aerial photographs. 'Single activity limits' are defined as how much of a single activity will risk causing a 500 m channel to degrade from *high* to *good* or *good to less than good* status (and by extension to *moderate*, *poor* and *bad*). For rivers, a channel typology is used to weight 'activity footprints' in order to reflect different sensitivities of 'eco-geomorphic attributes' within different types of channel (e.g. bedrock/cascade channels are deemed less sensitive to low gradient active meandering systems). The limits, based on percentage of capacity used relate back to waterbody status and reflect UK TAG's MCL's as shown in the table below.

River Zone	**Capacity Used**	
	High – Good Status	**Good – Moderate Status**
Channel	5%	15%
Bank and Riparian	5%	15%

Document 6.8
WFD 49(Rivers): A new impact assessment tool to support river engineering regulatory decisions – Short summary and response to project peer review and Field Trialling – MImAS (2006)

SNIFFER

Assessment of the Morphological Condition Limits and the MImAS tool was undertaken by comparing outputs from the tool with professional judgement of the morphological/ecological status of ninety 500m river reaches with status values ranging from High to Bad.

River engineering footprint activities included bank protection, weirs and culverts, dredging and gravel extraction, channel realignment and embanking.

The report concluded that MImAS appears to be an effective risk based assessment tool for assessing the impact of river engineering activities along 500m stretches. Continued data collection to inform a rolling programme of model evaluation was recommended perhaps in line with River Basin Management Plan (RBMP) cycles.

Document 6.9
NS SHARE: Guidelines for the Assessment of the Hydromorphological Status of Rivers, Part I Principles DRAFT (2005)

Cambridge University
Work has been undertaken through the NS SHARE project to develop a methodology for assessing hydromorphological status of waterbodies. Part I discussed the principles behind the development of the Rapid Assessment Technique (R.A.T).

The underlying principle of the assessment technique is based on six types and requires consideration of a matrix of eight ecologically-relevant river attributes i.e.

9. Channel Morphology and Flow Types
10. Channel vegetation
11. Substrate diversity and condition (embeddedness)
12. Channel flow status (low flow conditions)
13. Bank structure and stability
14. Bank vegetation
15. Riparian land use
16. Floodplain – channel lateral connectivity

Attributes and their relevance to biological quality elements are described along with details of how an assessment is made.

Overall assessment of waterbody status – a "Hydromorph score" is assigned based on cumulative scoring of attributes as a percentage of the attributes score for the reference condition.

$$\text{"Hydromorph score"} = \frac{\Sigma \text{ Assessment scores}}{\text{Maximum possible score (reference conditions)}}$$

WFD Class:
> 0.8 = high status
0.6 – 0.8 = good status
0.4 – 0.6 = moderate status
0.2 - 0.4 = poor status
< 0.2 = bad status

Document 6.10
NS SHARE: Guidelines for the Assessment of the Hydromorphological Status of Rivers, Part II Assessment Procedure DRAFT (2005)
Cambridge University

Part II details the assessment methodology.

The assessment methodology involves a semi-quantitative rapid assessment technique of sites supported by the use of map and aerial photography (remote sensing) to allow measurement of parameters from a desk study where possible. The measurement of deviation from reference state is the principle indicator of status, with allowances for spatial variability i.e. river typology.

Assessment Guidance Sheets for field use have been designed, giving a brief description of the aim of the attribute, typical condition categories for each score, the undisturbed state for each stream type, a short list of pressures that may affect the attribute for a particular stream type, and broad outlines of the departure from high status under the influence of pressures.

Once a specific reach to be assessed has been selected using a map of the drainage network, an initial GIS-and aerial photography-based desk study is to be used to identify the expected stream type according to defined criteria. A range of reach and catchment scale information is also recorded.

Assessment is supported by photographs showing both reference conditions for each generic stream type, and the effects of disturbance on a range of attributes for a range of stream types.

The assessment has been presented in a series of steps as a decision making process:

5. Design of a sampling programme for waterbodies and reaches;
6. Definition of river typology for each waterbody;
7. Assessment of set of semi- quantitative attributes to measure proximity of each reach to the reference state for its type;
8. Overall assessment of waterbody status – a "Hydromorph score" is assigned based on cumulative scoring of attributes as a percentage of the attributes score for the reference condition.

Document 6.11
River Habitat Survey in Britain and Ireland, Field Survey Guidance Manual: (2003 Version)
EA, SEPA, EHS

River habitat survey (RHS) is a method designed to characterise and access, in broad terms, the physical structure of freshwater streams and rivers. The field survey element does not require specialist geomorphological or botanical expertise, but recognition of vegetation type and an understanding of basic geomorphologic principles and processes are needed.

RHS is carried out along standard 500m length of river channel. Observations are made at ten equally spaced spot checks along the channel, whilst information on valley form and land use in the river corridor provides additional context. The RHS database contains field observations, map- devised information and photographs from more than 4600 RHS baseline survey sites visited in 1994-96 and over 12,000 subsequent surveys.

Surveys have been used for a number of purposes, including: determining the catchment characteristics of several rivers in the UK: identifying the attributes of known top quality "benchmark" sites; investigating possible species – habitat relationships; and providing input to environmental impact assessment.

This guidance manual also includes guidance (scope , health and safety , access and permissions, preparatory work, survey form, general site and surveyor information, spot checks, sweep- up information, channel dimensions, influences and special features, suitable conditions and season , quality control and contact of requires), health and safety documents, photographs and technical appendices.

Document 6.12
Linking organisms to natural and modified river hydromorphology by the analysis of existing data (Proposed Research)
Dr Ian Vaughan & Prof. Steve Ormerod,
Cardiff University

A proposal was submitted to UK TAG in 2006 by Cardiff University for the analysis of existing data collected by regulatory agencies to with the objective of advancing ecology-hydromorphology links.

The plan is to relate the distributions of a wide range of organisms to hydromorphology in a large sample of river sites with semi-natural or modified channels. RHS is to be primarily used in conjunction with large biological datasets (eg BIOSYS). The key aims are:

(1) To develop the evidence base for managing and regulating hydromorphological modifications and pressures
(2) To perform analyses tailored to support or augment specific management tools under development such as MImAS.

In the absence of scientific evidence, management tools such as MImAS have had to rely on expert judgement. This research should help to reveal which types and/or extent of modification are damaging as opposed to being relatively benign, in turn helping to refine management tools such as MImAS. Two suites of analysis are planned:

(A) Broad brush study using RHS, Biological and Chemical data using diatoms, macroinvertebrates and macrophytes;
(B) More detailed geographical focus to achieve a more holistic understanding of the pressures that affect river organisms.

Sites chosen for analysis have matching biological, RHS and chemical data (within 500m).

This work is currently ongoing.

Document 6.13
WFD42 - Development of a Technique for Lake Habitat Survey (LHS) (2006)
SNIFFER

This SNIFFER project produced a method for surveying and recording the morphological characteristics of lakes. The survey method was also designed to assess habitat quality of lakes.

The summary metric, the Lake Habitat Modification Score (LHMS), uses a set of 6 pressures with a range of 5 scores, graded by intensity, to classify lake modification.

This project alone was unable to develop LHS with the ability to make a sufficiently strong link between morphological characteristics and the ecology of the lakes. This was mainly due to a lack of corresponding ecological data to refine the scoring system.

Document 6.14
WFD49a - Development of Decision Making Frameworks for Managing Alterations to the Morphology of Lakes (2006)
SNIFFER
This work contracted to Dundee University also produced a summary metric, known as the Alteration of Lake Morphology Score (ALMS). This metric relies to a large extent on information obtained through LHS, but can also be used in conjunction with aerial photographs and maps. It looks at 12 pressures, each graded by 3 intensities, to classify the amount that each lake has been modified. The presence of bridges, causeways, fish cages, dredging, dumping, macrophyte control, and damage to the shore area through recreational use contribute to the ALMS. The pressures that are recorded by LHS but not used in ALMS are boat use, swimming, angling, fish stocking, power lines, liming, odour and surface films.

Document 6.15
WFD49a – Proposed Extension and Further Development (ongoing)
SNIFFER

SNIFFER Project WFD49f (49a extension) has been commissioned to Dundee University with the aim of provisionally defining a set of morphological Environmental Standards for lakes and a decision-support tool for regulatory practice within the UK. The ALMS scheme (alteration of lake morphology score) reported in WFD49a (2005) was considered to have operational

limitations because of the high input demands for field data and a relatively complex scoring system based on the expert judgement of the contractors. By contrast, the MImAS scheme (morphological assessment tool) developed in WFD49 produced a simpler and more pragmatic regulatory risk screening tool for rivers. This scheme considered fewer morphological pressures, the bulk of which can be assessed from desk-top analysis, and a set of fixed standards (morphological condition limits or MCLs) that have subsequently been ratified for use by regulators in the UK and already adopted by SEPA.

It is widely believed that the scientific principles underlying MImAS could be applied to TRaC (transitional and coastal) water bodies as well as to lakes. WFD 49f has the brief of re-aligning the ALMS scheme with key aspects of the MImAS approach which will provide greater consistency across all surface water types in the UK.

Document 6.16
NS SHARE The development of a methodology for collecting hydromorphology data in lakes (Parts 1, 2 & 3) DRAFT (2005)
Professor Robert Duck, Dundee University

This work comprised 3 parts and was commissioned through the NS SHARE project with a view to developing a methodology for collecting hydromorphology data in lakes. The recommendations of this report mirrored the approach in the UK, by suggesting that the revised form of LHS i.e. ALMS could be used in NS SHARE lakes, but that developments in the UK with respect to LHS and its associated scoring method as per Documents 6.14 to 6.16 should be monitored to ensure a co-ordinated approach in NI and RoI.