SOUTH WESTERN RIVER BASIN DISTRICT

MARINE MORPHOLOGY
NATIONAL METHODOLOGY REPORT

South Western River Basin District Project Office
5 Eastgate Avenue
Little Island
Cork

Job Nr: B1537400 June 2008

Revision Control Table

User is Responsible for Checking the Revision Status of this Document

		For & On Behalf of SWRBD Project Office			
Rev	**Description of Changes**	**Prepared By**	**Checked by**	**Approved by**	**Date**
A	N/A – First Issue	K Garry J Massey J Barlow	C Farrell	J McKenna	April 2008
B	Updated following Marine Morphology Steering Group Review and Approval	K Garry	C Farrell	J McKenna	June 2008
	Signed:				

TABLE OF CONTENTS

				Page
	GLOSSARY OF TERMS			**i**
	EXECUTIVE SUMMARY			**vii**
1	**INTRODUCTION AND BACKGROUND**			
	1.1	**The Water Framework Directive & Morphology**		**3**
	1.2	**Initial Risk Assessment**		**6**
	1.3	**Overall Approach – Marine Morphology PoMs Study**		**10**
	1.4	**Report Structure**		**14**
2	**LITERATURE REVIEW**			
	2.1	**Introduction**		**1**
	2.2	**Conclusions**		**10**
3	**DATA REVIEW**			
	3.1	**Introduction**		**1**
		3.1.1	Metadata	2
		3.1.2	Interim Data Review	2
		3.1.3	Tool Development	5
	3.2	**Final Data Review Findings**		**6**
		3.2.1	Baseline Data	7
		3.2.1.1	***TraC Water Body Boundaries***	7
		3.2.1.2	***Irish Coastline / High Water Mark***	8
		3.2.1.3	***Intertidal Area***	9
		3.2.1.4	***CORINE***	10
		3.2.1.5	***Foreshore Licence/Lease Register***	10
		3.2.1.6	***Environmental Impact Statement Register***	11
		3.2.1.7	***Coastal Images***	12
		3.2.1.8	***Historic Maps***	17
		3.2.1.9	***Bathymetric Data***	17
		3.2.2	Pressures	**18**
		3.2.2.1	***Dredging, Other Disturbances & Disposal at Sea***	21
		3.2.2.2	***Piled, Flow and Sediment Manipulation Structures***	29
		3.2.2.3	***Shoreline Reinforcement***	33
		3.2.2.4	***Flood Embankments***	37
		3.2.2.5	***Impounding Structures & Causeways***	41
		3.2.2.6	***Land Claim***	46
		3.2.2.7	***Intensive Land Use***	48
		3.2.2.8	***Abstractions***	50
	3.3	**Morphology**		**52**
		3.3.1	Data Resources	52
	3.4	**Ecology**		**53**
		3.4.1	Data Resources	53
		3.4.2	Methodology for Assessing Ecology	57
	3.5	**Pressure Footprints**		**57**
	3.6	**Delivery and dissemination**		**58**
	3.7	**Recommendations for Further Data Requirements**		**59**
		3.7.1	Baseline Data	60
		3.7.2	Morphological Data	60
		3.7.3	Pressures	61
	3.8	**Conclusions**		**63**

4 REVIEW OF EXISTING MONITORING SYSTEMS

4.1 Introduction 2
4.2 Review of Organisations Involved 3
4.3 Review Summary of Existing Marine Monitoring 7
4.3.1 Introduction 7
4.3.2 Pre-WFD Monitoring Programmes 8
4.3.3 Variable Measured for Marine Water Samples 13
4.3.4 Environmental Impact Assessments / Investigations 16
4.3.5 Conservation Monitoring 16
4.3.6 Post-WFD Monitoring Programmes 17
4.4 Water Framework Directive Monitoring Programme for TraC Waters 19
4.5 Conclusions 25

5 MORPHOLOGICAL IMPACT METHODOLOGY AND ASSESSMENT TOOL

5.1 Introduction to Morphology/Ecology Relationships in the Context of the WFD 2
5.2 Transitional and Coastal Morphological Impact Assessment System 11
5.2.1 Module 1: Eco-geomorphic Attributes 13
5.2.2 Module 2: Typology 16
5.2.3 Module 3: Sensitivity Assessment 17
5.2.4 Module 4: Impact Assessment (Pressures) 18
5.2.5 Module 5: Capacity Based Scoring System 19
5.3 Pressures 23
5.3.1 Land Claim & Tidal Realignment 24
5.3.2 Dredging, Other Disturbances to Seabed, & Disposal at Sea 25
5.3.3 Piled Structures 29
5.3.4 Flow and Sediment Manipulation Structures 30
5.3.5 Impounding Structures & Causeways 31
5.3.6 Shoreline Reinforcement 34
5.3.7 Flood Embankment 36
5.3.8 Intensive Land-Use 37
5.3.8.1 Salt Marsh Grazing 40
5.3.8.2 Peat Bogs 41
5.3.8.3 Intensive Sea Use 42
5.4 Development & Use of TraC-MImAS for the Purpose of Risk Assessments 44
5.4.1 Clonakilty Harbour (SW_100_0100) 44
5.4.2 Development and approval stages of TraC-MImAS for use as a morphological assessment tool in Ireland 53

6 FURTHER CHARACTERISATION METHODOLOGY & OUTCOMES

6.1 Introduction 1
6.2 Methodology - Further Characterisation 4
6.2.1 Assumptions 4
6.2.2 Water Body Typology 4
6.2.3 TraC-MImAS Application (Steps 1 - 3) 6
6.3 Results - Further Characterisation 11
6.3.1 Results of Step 1 16
6.3.2 Results of Step 2 16
6.3.3 Results of Step 3 17
6.3.4 Water bodies further characterised as at risk of failing to achieve Good Ecological Status 31
6.3.5 Results Summary 31

7 GOOD PRACTICE REVIEW FOR MORPHOLOGICAL MITIGATION MEASURES

7.1 Introduction 1
7.2 Key Definitions and Concepts 2
7.2.1 WFD Morphological Conditions in Transitional and Coastal Waters 2
7.2.2 Conceptual frameworks for restoration and recovery in TraC environments 2
7.3 Review Process 4
7.3.1 Information Reviewed **4**
7.4 Potential Types of Measures 8
7.5 Contents and use of the accompanying spreadsheet (Appendix 7-1) 9
7.6 Identifying Potential Measures 10
7.6.1 Applying the good practice guidance 10
7.6.2 Information on costs/cost effectiveness 10
7.6.3 A decision-making framework to select measures 13

8 FUTURE TRENDS

8.1 Introduction 1
8.2 Drivers Sectors 2
8.2.1 Coastal Defence and Flood Management 3
8.2.2 Sea-level rise 4
8.2.3 Infrastructure 6
8.2.4 Navigation 10
8.2.5 Recreation 12
8.2.6 Agriculture 12
8.2.7 Mining, Quarrying and Mineral Extraction 13
8.2.8 Water Abstraction 14
8.3 Conclusions 15

9 RECOMMENDATIONS FOR THE DESIGN OF THE MONITORING PROGRAM

9.1 Introduction 1
9.2 Recommendations for baseline conditions and change 1
9.2.1 Baseline Conditions (existing status) **1**
9.2.2 Monitoring of morphological changes 8
9.2.3 Intertidal 8
9.2.4 Subtidal, Coastal and Transitional 9
9.3 Recommendations for Information Requirements 11
9.4 Conclusions 16

10 RECOMMENDATIONS FOR THE DESIGN OF THE PROGRAMMES OF MEASURES

10.1 Introduction to the Requirements for a Programme of Measures 3
10.1.1 Basic Measures **6**
10.1.2 Supplementary Measures **8**
10.2 Existing Legal Framework Relevant to Morphology in TraC Waters 9
10.2.1 Responsible Bodies Governing Irish TraC Waters 9
10.2.2 Legislative Structure Governing Irish TraC Waters 10
10.2.2.1 Governing Legislation - International 10
10.2.2.2 Governing Legislation - European 11
10.2.2.3 Governing Legislation - National, Regional and Local Levels 20
10.2.2.4 Guidance 27

10.2.3 Conclusions from Legislative Appraisal (Basic Measures) 29
10.3 Recommendations for Basic Measures and Supplementary Measures 31
10.4 Prioritisation of TraC Water Bodies for the Application of Appropriate Measures 33
10.4.1 Introduction 33
10.4.2 Prioritisation of TraC Water Bodies 40
10.4.3 Identification of Appropriate Measures 50
10.5 Overall Conclusions 63

11 RECOMMMENDED REGULATORY DECISION SUPPORT METHODOLOGY FOR FUTURE USE
11.1 Introduction 1
11.1.1 Planning and Environmental Impact Assessment 2
11.1.2 The WFD and Physical Modifications 5
11.2 Decision Support for the Regulation of Physical Modifications 9
11.2.1 Regulatory Process for the Authorisation of Developments consisting of Physical Modifications 11
11.2.2 Screening 13
11.2.3 Pre-application Discussions 14
11.2.4 Scoping 16
11.2.5 Receipt of Application 16
11.3 Worked Example: Inner Bantry ay Proposed Harbour Development 18
11.3.1 Pre-application Discussions 20
11.3.2 Scoping 21
11.3.3 Receipt of Application 30
11.4 Further Development 30
11.4.1 Base Data and TraC-MImAS 30
11.4.2 Water Body Scaling and Single Activity Limits - Thresholds for screening 34

12 REFERENCES

APPENDICES

2-1 Literature Review

3-1 Data Review

3-2 Environmental Impact Statements

6-1 RoI MImAS Trial Results Version M2d

6-2 pHMWB MImAS Trial Results Version M2d & pHMWB MImAS Trial Results Version M2f

6-3 Overall Results

6-4 WB Summary Sheets

7-1 Interactive Good Practice Spreadsheet

10-1 Recommendations for the Design of the Programmes of Measures

11-1 Proposed Measures

GLOSSARY OF TERMS

ABP	Associated British Ports
ACE	Advisory Committee on Ecosystems
ACFM	Advisory Committee on Fishery Management
ACME	Adivsory Committee on the Marine Environment
AFF	An Foras Forbartha
ALAC	Aquaculture Licence Advisory Committee
ALSM	Airborne Laser Swath Mapping
AMAP	Arctic Monitoring and Assessment
AMBI	ATZI Marine Biotic Index
ArcGIS	Geologic Information System software (ESRI)
Art 5	Article 5
ATBI	All Taxa Biodiversity Index
AWB	Artificial Water Bodies
BDC	Biodiversity Committee (OSPAR)
BGS	British Geological Survey
BIM	Bord Iascaigh Mhara
BioMAR	Identification, description and mapping of biotopes project.
BP	Best Practice
BPP	Biological Primary Production
CCW	Countryside Council for Wales
CDT	Conductivity, Depth and Temperature
CEDA	The Central Dredging Association
CEFAS	Centre for Environment Fisheries and Aquaculture
CFB	Central Fisheries Board
CFRAMS	Catchment Flood Risk Assessment and Mapping Studies
CIA	Central Intelligence Agency (US)
CICRA	Communication Information Resource Centre Administrator
CIRIA	Construction Industry Research and Information Association
CIS	Common Implementation Strategy
CIWEM	Chartered Institute of Water and Environmental Management
CMRC	Coastal and Marine Resource Centre
CMS	Coastal Management for Sustainability
COAST	WFD Working Group for Typology, Reference Conditions and Classification of Transitional and Coastal Waters.
CoCo	County Council
CORINE	Coordination of Information on the Environment
COZAS	Coastal Zone Administration System
CREH	Centre for Research into Environment and Health
CRP	Collaborative Research Programme
cSAC	Candidate Special Areas of Conservation

CSO	Central Statistics Office
DAFF	Department of Agriculture, Fisheries and Food
DARD	Department for Agriculture and Rural Development
DCENR	Department of Communications, Energy and Natural Resources
DCMNR	Department of Communications, Marine and Natural Resources
DEFRA	Department for Environment, Food and Rural Affairs
DEHLG	Department of Environment, Heritage and Local Government
DoM	Department of Marine
DoT	Department of Transport
DPSIR	Driver, Pressure, State, Impact, Response
EA	Environment Agency
EC	European Commission
EcoServe	Ecological Consultancy Services Ltd
EEA	European Environment Agency
EEZ	European Economic Zone
EHS	Environment Heritage Service (NI)
EIA	Environmental Impact Assessment
EIHA	Working Group (OSPAR) on the Environmental Impact of Human Activities
EIS	Environmental Impact Statement
ENFO	Information on the Environment
EMS	Environmental Management System
EPA	Environmental Protection Agency
EQS	Environmental Quality Standards
ERBD	Eastern River Basin District
ERDF	European Regional Development Fund
ERI	Environmental Research Institute
ERU	Environmental Research Unit
ESB	Electricity Supply Board
ESPO	European Sea Ports Organisation
ESRI	Environmental Systems Research Institute, Inc
EU	European Union
EU INTERREG	EU funded programme that helps Europe's regions form partnerships to work together on common projects.
EUNIS	European Nature Information Centre
EUROSION	European study into coastal erosion at a European scale
FAO	Food and Agriculture Organisation (United Nations)
FCS	Favourable Conservation Status
FRC	Fisheries Research Centre
FTT	Fish Task Team
FW	Fresh water
GD	Guidance Document
GEBCO	General Bathymetric Chart of the Oceans

GEP	Good Ecological Potential
GES	Good Ecological Status
GIS	Geographic Information System
GNP	Gross National Productivity
GSI	Geological Survey of Ireland
HabMap	HABitat MAPping for conservation and management of the Southern Irish Sea
HELCOM	Helsinki Commission
HES	High Ecological Status
HGES	High or Good Ecological Status
HMWB	Heavily Modified Water Bodies
HWM	High Water Mark
IADC	International Association of Dredging Companies
IC	WFD Impacts and Pressure Working Group
ICES	International Committee for the Exploration of the Seas
ICZM	Integrated Coastal Zone Management
IEC	International Electrotechnical Commission
IFIS	Integrated Fisheries Information System
IHO	International Hydrographic Office
ILU	Intensive Land Use
IM	Investigative Monitoring
IMAGIN	Irish Sea Marine Aggregates Initiative
IMDO	Irish Maritime Development Office
IMPRESS	WFD Impacts and Pressure Working Group
INFOMAR	INtegrated mapping FOr the sustainable development of Ireland's MArine Resource
INSPIRE	Infrastructure for Spatial Information in the European Community, EU Directive 2007/2/EC
INSS	Irish National Seafloor Survey
IOSEA	Irish Offshore Strategic Environmental Assessment
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
ISO	International Standards Organisation
JMG	Joint Monitoring Group (OSPAR)
JNCC	Joint Nature Conservation Committee (UK)
LA	Local Authority
LGCSB	Local Government Computer Service Board
LiDAR	Light Detection And Ranging
LNG	Liquid Natural Gas
LWM	Low Water Mark
MarLIN	UK Marine Biological Association's Marine Life Information Network
MASH	Working Group (OSPAR) on Marine Protected Areas, Species and Habitats
MBA	Marine Biological Association
MBITT	Marine Benthic Invertebrate Task Team

MCLs	Morphological Condition Limits
MEP	Maximum Ecological Potential
MESH	Marine Environmental Seabed Habitats
MI	Marine Institute
MIDA	Marine Irish Digital Atlas
MImAS	Morphological Impact Assessment System
MLCs	Morphological Condition Limits
MLVC	Marine Licence Vetting Committee
MMDST	Marine Morphology Decision Support Tool
MNCR	Marine Nature Conservation Review
MTT	Marine Task Team
NBIRBRD	Neagh Bann International River Basin District
NBN	National Biodiversity Network (UK)
NDP	National Development Plan
NEMP	National Environmental Monitoring Programme
NHA	Natural Heritage Area
NI	Northern Ireland
NIMA	US National Imagery and Mapping Agency
NOAA	National Oceanic and Atmospheric Administration
NPWS	National Parks and Wildlife Service
NRA	National Roads Authority
NSS	National Spatial Strategy
NS-Share	North-South Share
NWIRBD	North Western International River Basin District
OECD	The Organisation for Economic Co-operation and Development
OM	Operational Monitoring
OPW	Office of Public Works
OSi	Ordnance Survey Ireland
OSPAR	Oslo and Paris Convention
OSPARCOM	Oslo and Paris Commissions
PAD	Petroleum Affairs Division
PDF	Portable Document Format
PIANC	Permanent International Association of Navigation Congress
PIP	Petroleum Information Programme
pNHA	Proposed Natural Heritage Area
PoMS	Programme of Measures and Standards
PoMs	Programme of Measures
PPP	Proposed Plans and Programmes
PRB	Pilot River Basin
PROCLAN	WFD Working Group for Best Practices in river basin planning
PTT	Plant Task Team
RA	Risk Assessment

R & D	Research and Development
RBD	River Basin District
RBMP	River Basin Management Plan
RBMS	River Basin Management Strategy
REFCOND	WFD Reference Conditions in inland waters working group
REPS	Rural Environmental Protection Scheme
ROI	Republic of Ireland
RPII	Radiological Protection Institute of Ireland
PSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SAHFOS	Sir Alister Hardy Foundation for Oceanic Sciences
SBS	Sea Bed Sediment
SDT	Secchi disc transparency
SEA	Strategic Environmental Assessment
SEABED	Working Group (OSPAR) on the impact on the seabed
SensMap	Sensitivity and mapping of inshore marine biotopes in the southern Irish Sea
SEPA	Scottish Environmental Protection Agency
SERBD	South Eastern River Basin District
SFPA	Sea-Fisheries Protection Authority
SGSOBS	Study Group on Ecological Quality Objectives for Sensitive and for Opportunities Benthos Species
ShIRBD	Shannon International River Basin District
SIAM	Synergies in Assessment and Monitoring
SM	Surveillance Monitoring
SNH	Scottish Natural Heritage
SnapMap	Oblique coastal helicopter survey image viewer (DCENR)
SNIFFER	Scotland and Northern Ireland Forum For Environmental Research
SPA	Special Protection Area
SSSI	Special Site of Scientific Interest
SWMI	Significant Water Management Issues
SWRBD	South Western River Basin District
TCD	Trinity College Dublin
ToR	Terms of Reference
TraC	Transitional and Coastal
TraC-MImAS	Transitional and Coastal Morphological Impact Assessment System
UCC	University College Cork
UCD	University College Dublin
UK	United Kingdom
UKTAG	United Kingdom Technical Advisory Group
UNCLOS	United Nations Convention on Law Of the Sea
UNCSD	United Nations Commission on Sustainable Development
UNESCO	United Nations Educational. Scientific and Cultural Organisation

US	United States of America
USGS	United States Geological Survey
WASA	Wave and Storm in the Northern Atlantic group
WATECO	WFD Economic Analysis Working Group
WB	Water Body
WFD	Water Framework Directive
WG	Working Group
WGICZM	Working Group (ICES) on Integrated Coastal Zone Management
WGMDM	Working Group (ICES) on Marine Data Management
WRBD	Western River Basin District
XML	Extensible Markup Language

EXECUTIVE SUMMARY

The Marine Morphology Programme of Measures and Standards (PoMS) Study aims to provide a protocol to apply in the further characterisation and risk appraisal for morphology in transitional and coastal (TraC) waters, the outcomes of which will contribute to the development of a tool aimed at supporting the assessment and management of morphology in these water bodies.

The objectives of the study are as follows:

- Establish the relationship between morphology characteristics and biological status;
- Identify what level of morphological pressure is sustainable within a water body;
- Establish which morphological indicators should be included in TraC monitoring programmes;
- Identify water bodies where morphology restoration measures are required (linked to HMWB designation process);
- Identify the available buffer (or capacity) of water bodies in order to prioritise action levels;
- Prioritise morphology pressures; and
- Develop a decision support tool for regulators to assess the potential impact of future developments on individual water bodies (i.e. to prioritise activities and establish a tiered assessment system).

This study involves all 309 TraC water bodies within the Republic of Ireland (RoI), but was undertaken in parallel to the North-South Share (NS-Share) project to ensure compatibility of methodologies between Northern Ireland (NI) and the RoI.

The hydromorphological quality elements defined by Annex V of the WFD must be taken into account when assigning surface water bodies to high ecological status. For other status classes, the hydromorphological elements are required to have '***conditions consistent with the achievement of the values specified for the biological quality elements'*** (WFD, Annex V).

Member States are only required to report on hydromorphology for those water bodies designated as 'High Status'. For these water bodies it is assumed the European Commission will require information on the normative definitions, for example the structure of the water body's intertidal zone indicates little or no human impacts. It is important to note that the impact assessment tool used in this study can only indicate the likely risk to the WFD quality elements; monitoring results are required to quantify these risks.

The initial risk assessments completed across Europe have shown that hydromorphology is one of the most significant pressures operating in surface waters and therefore contributing to the failure to achieve WFD objectives.

The Irish initial risk assessments completed in 2005 concluded that 35% of transitional (estuarine) water bodies, and 18% of coastal water bodies within the RoI were ***'at risk'*** or ***'probably at risk'*** of failing to meet the WFD objective of 'Good' Status due to physical alteration. The Marine Morphology Study further characterises these risks by researching the relationship between morphology and ecology and further defining the pressures on morphology.

Literature Review

An initial step in achieving the objectives of the Marine Morphology study was to undertake a Literature Review. This review concluded that the most common, and in most cases necessary, approach to assessing and reporting the impact of morphological pressures on ecology involves a mixture of qualitative and quantitative assessments, and although it is clear that many anthropogenic activities which result in pressures to morphology have some impact on ecology there are limited quantitative data throughout Europe describing the relationships between morphological conditions and ecological health.

The lack of sufficient criteria and thresholds available to assess the risk of a water body failing to meet Good Status is being investigated by the UK-Ireland Marine Task Team. However, the progression of this work in relation to morphology, at the time of writing has yet to result in formal classification tools (criteria or thresholds).

The conclusions drawn by the Literature Review led to consideration of the Scottish Environment Protection Agency's (SEPA) Transitional and Coastal Morphological Impact Assessment System (TraC-MImAS) for the purpose of further characterisation of TraC morphological pressures and as a decision support tool for the future regulation of TraC water bodies in the RoI.

Data Review

In preparation for the use of the TraC-MImAS tool, where possible, a series of national marine morphology pressure datasets were created as shapefiles in a Geographic Information System (GIS). Various restrictions associated with data licence agreements were experienced throughout this process. This included the limited availability of orthophotos, coverage of which was essential to the creation of new pressure footprints.

However, the data was developed to the best scale and detail possible given the limitations experienced, to provide a comprehensive and consistent dataset for Ireland.

The confirmation of an 'end user' of such a tool was fundamental to the licence agreements and data requests required for this study. However, notwithstanding support from the Marine Morphology Steering Group an appropriate end user for this tool has not as yet been identified. As a temporary alternative, to ensure the progress of this study, the SWRBD, and Cork County Council, were identified as substitute end users. The SWRBD, and Cork County Council, have no function to hold or use such a tool for the purpose of regulation and are intended only as a temporary 'end user' until an appropriate assessment or regulatory body is identified.

Existing Monitoring

A review of existing European and national monitoring programmes was undertaken with the aim to determine if these programmes are of benefit to the assessment of morphological conditions within TraC waters.

There are two main requirements for marine morphology data under the WFD

- to determine the ecological status of a water body, and
- to detect change that may affect this status.

In order to assess these requirements, a morphological baseline is needed and investigative monitoring relating pressures to morphology must be collected. It is important to note that changes in morphology can be triggered by natural changes in TraC waters and this should be considered in the collection and interpretation of monitoring results.

Monitoring for both baseline and change of morphology is a difficult process. Natural morphological change occurs over long periods and must therefore be monitored and reported as time series data. The morphological quality elements prescribed by the WFD have yet to be formally adopted within a classification system. The difficultly in classifying these elements has been demonstrated by the 'Metrics' project initiated by UK and Ireland Marine Task Team.

There are few national monitoring programmes specifically associated with morphological conditions. Monitoring has predominately been aimed at water quality and associated with the compliance of bathing and shellfish water legislation. In addition to this, protected areas require monitoring of their biological and environmental quality; but this assessment is generally infrequent and, with the exception of saltmarsh and benthic monitoring, is not of particular relevance.

Morphological Impact Assessment

The link between morphology and ecology is relatively well established in fluvial environments. However, there is less documented information and scientific research linking morphology to ecology in marine environments. In the context of the WFD, there is a need to understand how changes in the morphological quality elements (resulting from pressures) result in alteration to biological elements, causing them to be disturbed from the reference condition and leading to deterioration in quality status. It is acknowledged that there are currently gaps in understanding many of these linkages, particularly at the water body scale. Future monitoring has the potential to increase understanding of these relationships (together with physico-chemical elements).

Although a review of recent seabed mapping projects (***MarLIN*** and SensMap), and development of links between habitat and species in marine environments, show that there are sound theoretical bases for assuming that changes to morphology brought about by pressures will have resulting impacts on ecological and biological features, the absence of suitably detailed baseline data to use these methods now for the WFD means that the first round of river basin planning will need to rely on tools which focus on general links between morphology and ecology.

In order to be able to estimate and report on the risk posed by morphological alterations to the ecological status of TraC water bodies, morphological impact assessment tools were investigated. Firstly the Marine Morphology study investigated the use of marine 'Metrics' which were being developed by the UK Environment Agency in association with the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) as part of a project to develop hydromorphological reference conditions and a draft classification scheme for TraC waters. This project was focused on defining only high status and the boundary between high/good, and emphasised that the biological classification scheme should incorporate metrics that are sensitive to hydromorphological changes. The threshold limits proposed by this study were largely based on expert judgement due to considerable limitations in current understanding and availability of data.

In determining a suitable framework which could facilitate the development of environmental standards for TraC waters within the time scales required of the first river basin planning cycle, the UK Technical Advisory Group (UKTAG) reviewed both these Metrics and the River Morphological Impact Assessment (MImAS) tool being applied in Scotland. UKTAG concluded that the framework currently being developed for the Metrics would require further development within a more structured framework to allow environmental standards to be developed and approved. Following a request from UKTAG to determine if the MImAS framework could be successfully adopted for TraC waters, it was confirmed that the scientific principles underpinning MImAS were transferable to TraC waters. Therefore work on a draft TraC-MImAS tool commenced.

Participation in the UKTAG TraC Morphology Steering Group and the TraC-MImAS Technical Panel Ireland (RoI and Northern Ireland Marine Morphology PoMS teams) supported the development of TraC-MImAS.

The TraC-MImAS tool was developed with the intention to help regulators determine whether changes to the morphology of TraC waters could pose a risk to ecology, and thereby identify those proposals that could:

- Threaten the aim of achieving 'good ecological status'; or
- Result in a deterioration in ecological status

The TraC-MImAS tool is not intended to provide a detailed assessment of ecological status, but rather provide a means of identifying where ecological conditions are likely to be impaired through impacts to morphology, i.e. it is based on the assumption that an assessment of impacts on ecologically relevant features and processes can be used to protect morphology and ecology.

The tool uses a concept of 'system capacity' (allowable morphological change) to measure impacts to morphological conditions, assuming that pristine TraC waters have a measure of assimilative 'capacity', which can be degraded by anthropogenic activities. SEPA have defined 'system capacity' as:

A measure of the ability of the water environment to absorb morphological alterations. The likelihood (or risk) that morphological and ecological conditions are degraded will increase as system capacity is consumed. This concept does not infer that degradation of the environment is acceptable; rather it assumes that there is a degree to which minor changes can be tolerated by the system.

TraC-MImAS is underpinned by a series of assumptions:

1 A TraC water body has some capacity to accommodate morphological change without changes to its ecological status.

2 There is a relationship between the extent of morphological alteration and the impact on ecological status.

3 The response of a water body's morphology to an engineering activity or other pressure is predictable for that type of water body.

4 The response of the ecology to morphological change is predictable and depends on the sensitivity of the ecology of the water body.

TraC-MImAS comprises 5 modules which combine to estimate the existing system capacity of a water body as a percentage.

Module 1: Eco-geomorphic attributes
Module 2: Typology
Module 3: Sensitivity assessment
Module 4: Impact assessment
Module 5: Capacity based scoring system

Each module can be updated independently thereby facilitating future development of this tool.

The eco-geomorphic attributes of Module 1 were chosen for their role in the direct or indirect support of ecological communities and the supporting processes needed to create and maintain the physical environment on which ecological communities depend and relevance to the morphological quality elements specified by Annex V of the WFD.

The function of TraC-MImAS is heavily reliant on the typology of water bodies, a point which was highlighted by the UK and Ireland Marine Task Team. It was agreed that the function of this tool would benefit greatly from the further improvement of this module (through further field assessments).

The sensitivity considered by Module 3 combines both the estimated morphological and ecological sensitivity of each TraC water body type. It is based on the likelihood that an eco-geomorphic attribute and its supported ecology will change in response to an applied pressure.

Module 4 forms a distinction between the intensity and extent of the likely impact of a pressure but indicating the likelihood that a pressure will impact an eco-geomorphic attribute, and whether these impacts are likely to be contained within the vicinity of a pressure footprint or be pervasive.

In the absence of Environmental Standards for morphology, TraC-MImAS uses Morphological Condition Limits (MCLs) to help quantify the potential risk that a new morphological alteration could impair achievement of the ecological objectives of the WFD. SEPA define the MCLs as "***thresholds of alteration to morphological conditions beyond***

which there is a risk that the ecological status objectives of the WFD could be threatened'. MCLs are expressed in terms of % capacity of a water body, and are defined for 3 TraC zones: Hydrodynamic; Intertidal; and Subtidal.

As with the thresholds investigated as part of the marine 'Metrics' study, the MCLs were largely based on expert judgement due to considerable limitations in current understanding and availability of data.

The UK and Ireland Marine Task Team agreed the following points in relation to the use of TraC-MImAS:

- The group was comfortable that the principles and approach underpinning TraC-MImAS are logical and reasonable.
- TraC-MImAS is suitable to support the three purposes defined by SEPA:
  - Regulatory risk assessments.
  - Identification of high status conditions for morphology.
  - Contribute to surrogate classification assessments for the other ecological status boundaries (but not to be used in isolation).
- The condition limits proposed are set at an acceptable level for incorporation into the UKTAG Environmental Standards report; however, these values should be reviewed and refined where possible.

The further development of the typology module of this tool was a key recommendation. With regard to the further development of the MCLs, further field assessments including investigative monitoring are required to refine the association between these values and morphological and ecological status class.

Working with SEPA, TraC-MImAS trials were undertaken in Ireland to assist in its development process. The purpose of the trials was to test the appropriateness of the MCLs and the also the framework within which MImAS may be applied to support regulation.

TraC-MImAS was updated on completion of both these trials and an external technical review undertaken by Anton Edwards of Metoc Environmental Consultants.

TraC-MImAS expresses the risk of a water body failing WFD objectives by indicating the potential ecological status class that may be achieved based on the water body type and pressure extents identified. For example, a result of 'Good' indicates that this water body is potentially at risk of failing to achieve high morphological status and in turn high ecological status. It is important to note that the results of this study are wholly based on the detailed risk assessment undertaken for the purpose of further characterising TraC waters, and any reference to status class boundaries is wholly based on this risk assessment and has not been verified by field assessments or reference to biological classification. The formal classification of morphological status for TraC water bodies in Ireland is outside the scope of the Marine Morphology Study.

Following endorsement by the both the Marine Morphology Steering Group and Marine Task Team, TraC-MImAS (version M2f (final)) was applied to Irish TraC water bodies for the purpose of further characterising the risk associated with anthropogenic physical alterations.

Further Characterisation

Of the 309 TraC water bodies, 122 were prioritised for further characterisation using TraC-MImAS. This prioritisation was based on a number of assumptions agreed with the Marine Morphology Steering Group. In addition, TraC-MImAS was also applied to a further fourteen water bodies following a request from the EPA.

Further characterisation of pressures on TraC water bodies concluded that the NWRBD and WRBD contain the least percentage coverage of morphological pressure footprints identified. Also, with the exception of ‘low impact dredging’ (maintenance) and ‘other disturbances to seabed’, morphological pressures are generally most extensive within transitional water bodies. This was an expected result as many of Ireland’s urban/industrial areas as well as sensitive coastlines are concentrated within the transitional water bodies.

Low impact dredging and other disturbances to seabed are significant pressures within all River Basin Districts (RBDs). Low impact dredging is of most significance within the Shannon and South Western RBDs, where this pressure was identified as associated with the maintenance of both shipping navigation channels and drainage channels. The pressure ‘other disturbances to seabed’ combining the footprints of shellfish dredging, ferry channels, marine cables and pipelines, and areas zoned for wind farm development is dominated by areas designated for shellfish dredging. Licensed shellfish areas noted by this assessment occupy approximately 17 % of the TraC water body area. It should be noted that the detailed assessment of the impact of aquaculture practices is outside the scope of this study and the areas identified as shellfish dredging areas are not necessarily the “worked” area.

Shannon International River Basin District (ShIRBD)

The ShIRBD exhibits the most extensive shoreline and areal pressure footprints. However, the areal pressures are primarily associated with low impact dredging and other disturbances to seabed; the latter of which requires further assessment of aquaculture areas to confirm pressure extents. Nearly 14% of this river basin district's shoreline is embanked, which is 11% greater than any other RBD. This extensive network of embankments within the ShIRBD is heavily concentrated on the following water bodies:

- Cashen
- Fergus Estuary
- Maigue Estuary
- Upper Shannon Estuary

Eastern River Basin District (ERBD)

The ERBD is also subject to extensive shoreline pressure footprints, with nearly 13% of its entire shoreline reinforced. Also, approximately 38% of the ERBD TraC water body area is subject to pressures such as low impact dredging (maintenance dredging), land claim and other disturbances to seabed. The latter pressure consists of footprints for shellfish dredging, vessel movements, and marine cables and pipelines; shellfish dredging was identified as the most significant of the three. Over 1% of this RBD's coast has been reclaimed, a significant proportion of which is in the Dublin area.

Neagh-Bann River Basin District (NBRBD)

The most significant pressure footprints identified for the NBRBD TraC water bodies are those associated with other disturbances to seabed, low impact dredging and embankments. Of those embankments identified all features were concentrated within the Glyde and Ballymascanlan Estuaries.

South Western River Basin District (SWRBD)

A significant proportion of the SWRBD's TraC water body area has been identified as impacted by shellfish dredging, which is a component of the pressure 'other disturbances to seabed'. Second only to the ShIRBD, over 6% of this RBD's total water body area is subject low impact dredging. The majority of the high impact shoreline reinforcement identified is concentrated on the transitional water bodies.

South Eastern River Basin District (SERBD)

Second only to the ERBD, a significant portion of the SERBD's shoreline is subject to high impact shoreline reinforcement. The other significant pressures identified for this RBD are low impact dredging and other disturbances to seabed.

Western River Basin District (WRBD)

The most significant pressure on the WRBD TraC water bodies is that associated with shellfish dredging, with over 25% of its area designated as the pressure ‘other disturbances to seabed’. Low impact dredging also contributes to the morphological pressures within this district, whereas footprints for all other pressures are minimal.

North Western River Basin District (NWRBD)

Limited pressure footprints were identified for this RBD as a whole, with the most extensive pressures of low impact dredging and ‘other disturbances to seabed’ present in approximately 5% and 10% of the TraC water body area respectively. Although the results indicate that pressure footprints are limited for the RBD overall, the concentration of embankments within the following water bodies has significant impact on their potential to achieve GES:

- Blanket Nook Lough
- Foyle and Faughan Estuaries
- Inch Lough
- Swilly Estuary

Further characterisation of the pressures on the morphology of Irish TraC water bodies has concluded that 12% of transitional water bodies, and 2% of coastal water bodies within the Republic of Ireland are likely to be at risk of failing to meet the WFD objective of good ecological status. At this stage of assessment, prior to confirmation via monitoring and formal classification, 12% of transitional and 10% of coastal water bodies indicate the ability to achieve high ecological status.

Good Practice Review

Existing information relating to good practice measures for activities involving hydromorphological alterations to TraC waters has been collated within an interactive database to aid decisions which aim to identify appropriate measures.

Measures relating to morphology in TraC waters will be those that seek to prevent deterioration, maintain status/quality, or ‘restore’ conditions, related to:

- Depth variation
- Structure and substrate of the subtidal bed
- Structure of the intertidal zone

The hydrological elements are strongly connected with these and include the direction of dominant currents, the degree of wave exposure, and the amount of freshwater flow in estuaries.

There is potential for the recommended good practice measures themselves to result in direct or indirect changes to morphological conditions; for example the use of training walls to reduce the frequency of dredging operations in estuaries (to promote self-scouring) may impact on all three of the morphological elements listed above.

The measures reviewed can be classified as:

- General good environmental practice and management plans
- Mitigation measures
- Restoration measures
- Natural recovery (which should not be discounted as an option)

Detailed information on these measures, including theory and case studies, is included in the database appended and the reference links within.

In reviewing generic 'Good Practice', it is important to emphasise that mitigation measures that have proven successful in one location may not be directly applicable in other environments. Most good practice guidance emphasises the need for site-specific investigations and design in the context of a wider strategy (in this case the strategic scale is led by the RBMP).

Various economic-based research reports of relevance to morphology were identified, summaries and reference links to which are provided in the database. These include the development of a methodology to assess disproportionate costs, a database for benchmark costs and guidance on applying cost-effectiveness methodology, and a scoping report with specific focus on economic impacts in TraC waters. The latter concludes that the financial and economic implications for sectors operating in TraC waters could be significant.

Costing of individual measures is difficult for a number of reasons. Specific examples include: the lack of available and up to date data (often information is confidential and related to contracts); the geographical scale of implementation required; site specific details and the necessary costs of feasibility and design; and the associated costs of legislative or other mechanisms to implement the measures.

Measures which might be achievable at minimum cost typically include: the development or application of codes of good practice; better enforcement of (often existing) local regulation; some zoning initiatives; and various research initiatives. Potential measures involving anticipated moderate costs include: some research initiatives; required modifications (whether to plant, gear or working methods); and/or certain types of constraints imposed on activities by regulatory bodies. Depending on specific details, measures prohibiting certain activities or working methods (e.g. certain dredging techniques) may be shown to be disproportionately costly, particularly if the full range of consequential costs is considered in the analysis.

Future Trends

The WFD presents a need to analyse not only existing pressures on water bodies, but also those that may influence the achievement of the WFD objectives by 2015.

The main overarching trends likely to affect marine morphology are climate change and associated sea level rise, and the effect these have on coastal areas, causing increased flood risk and the need for coastal protection.

The uncertainties of climate change make it difficult to predict with any accuracy, the coastal protection or other measures that might be associated with sea level rise / increase in storm surges or possible impact of freshwater shortages that could affect Ireland in the future.

Additional pressures, linked to climate change, include the possibility of water demands exceeding supply in some areas, resulting in the need for water abstraction and potentially desalination, to meet requirements. The possibility of these water shortages could change agricultural patterns and could place more pressure on coastal areas by increasing the need for expansion of fisheries and aquaculture industries to meet growing demands.

Pressures from ports and coastal population centres are also likely to develop in coastal areas and estuaries. Ireland is reliant on sea transport for much of its trade; therefore it is considered that all major Irish ports are likely to expand in the near future together with the addition of new facilities to distribute and augment national capacity. Ports often expand by land claim or require additional shoreline reinforcement and flow modification structures to operate. Ports are responsible for safe navigation, which will involve continued or more intensive (for larger vessels) dredging of channels and berths, and the dumping of this material at sea whenever re-use is not appropriate.

Marine energy generation is also likely to increase in the near future. Oil and Gas exploration licencing is currently being rolled out in Ireland with the National Energy Policy highlighting the need for safeguarding Ireland's energy supplies. Also within the energy policy are drivers to increase the amount of renewable energy production, and marine technologies (wind, wave and current) are likely to increase in the near future. The expansion of these industries will also result in increased requirements for subsea pipelines and cables.

Coastal and marine recreation are also important sectors which are likely to increase, resulting in an increase of coastal structures and facilites, such as marinas.

Finally, there have been programmes undertaken to assess the offshore agregates available to Ireland. As terrestrial sources become scarcer or more expensive, there is a possibility that marine aggregate industries may develop further in Ireland.

Ireland is likely to see an increase in the demand for coastal resources in the future, which will in turn increase the potential for coastal pressures. The recognition of these issues within each RBMP area will help contribute to the appropriate management of these pressures.

Recommendations for the design of the monitoring programme

For the purpose of the WFD, the EPA proposed to combine existing marine monitoring programmes into a strategic sampling programme. This monitoring programme has been scoped, proposed and costed by the Marine Institute and EPA; however, this did not include specific monitoring for marine morphology.

Following a review of existing and planned monitoring programmes, it is proposed to adapt and record morphological monitoring surrogates to existing programmes to assist in the monitoring of baseline conditions and the detection of changes.

Using the eco-geomorphic attributes considered in TraC-MImAS, details of the following are provided:

- Relevant parameter/s currently monitored (or potentially available via surrogate methods).
- Frequency and spatial extent of this data.
- The associated ecological observations from such monitoring.
- Recommendations for additional monitoring measures.

In summary, recommendations made for the design of a monitoring programme include:

- An increased, focused network of tidal gauges and current metering.
- A central repository for data collected by various studies such as those undertaken for EIAs and foreshore licence applications. These can provide useful sources of

information relating to the investigative monitoring of change associated with physical alterations. Also, this repository should include co-ordination with the INFOMAR programme and Special Areas of Conservation (SAC) baseline surveys to help build seabed sediment maps and bathymetry data for Ireland.

- Expansion of existing and proposed hydrometric monitoring downstream to TraC waters.
- Addition of salinity measurements at WFD monitoring sites.
- Co-ordination with flood monitoring to be undertaken for the purposes of meeting Floods Directive requirements.
- Co-ordination of the frequency of Ordnance Survey Ireland orthophotography and LiDAR data, and ground-truthing of data.
- Supplement current sediment monitoring with particle size analysis to ensure consistency.

It is essential for the monitoring of marine morphology, that a reliable baseline against which to make assessments and assess future development proposals is collected. There are a number of programmes already underway, (the most notable being INFOMAR), that can provide this information. However, they will not be complete until towards the end of this first river basin planning cycle.

As a result, it is proposed that records from a number of national survey and monitoring programmes be used to assess potential marine morphological changes until such time as this baseline is available.

Once this baseline is available it will be possible to investigate morphological changes that have caused ecological deterioration.

The execution of a detailed morphological monitoring programme and / or the adequate consideration of the morphology quality elements within existing programmes will assist in the achievement of the following requirements identified throughout the study:

Further definition of the relationship between morphology and ecology

In addition to seagrass and benthic monitoring to be carried out as part of the WFD monitoring programme, investigative monitoring of the impact of the identified pressures on morphological conditions is required. In the absence of a formal classification system the eco-geomorphic attributes recorded by this study should be considered.

The improvement of the typology module of TraC-MImAS is fundamental to the overall refinement of this tool. Monitoring of baseline conditions would contribute to the refinement of water body 'types'. The assessment of this can facilitate the division of water bodies into various sub-types to reflect the appropriate baseline conditions. Potential for further development may involve the possibility increasing the sensitivity of a water type if, for example, a large portion of its area is associated with saltmarsh i.e. the capacity of the water body is likely to be absorbed quicker due to the sensitivity [and conservation status] of saltmarsh habitats

Further development of TraC-MImAS as a regulatory support tool

To assist in the implementation of the recommendations proposed for Ireland's regulatory framework, additional monitoring and appraisal of the pressures should be undertaken to develop adequate baseline information on the morphology of TraC water bodies as well as evidence-based thresholds for the consideration of risk (refinement of Morphological Condition Limits).

Recommendations for the design of the programme of measures

The WFD requires the setting of objectives for all water bodies; compliance with standards and objectives set for protected areas; and the implementation of cost effective programme of measures to meet those objectives.

The term 'measure' can refer to both the physical actions required to achieve objectives e.g. good practice, as well as the mechanisms required to recommend and / or enforce these actions, i.e. existing and future decision and evaluation processes in place to assess physical modifications with the aim of protecting morphology and ecology. The 'physical actions' should consist primarily of ***supplementary measures*** whereas mechanisms can be addressed by either ***supplementary*** or new ***basic measures***.

With regard to the existing mechanisms (legal framework) governing Irish TraC waters it is important to note that following the general elections held in May 2007 various responsibilities relating to coastal waters were transferred between government departments. Responsibilities are currently split between the Department of Environmental, Heritage and Local government (DEHLG), the Department of Agriculture Fisheries and Food (DAFF), and the Department of Communications, Energy and Natural Resources (DCENR) [and Local Authorities in relation to planning].

Following on from an appraisal of good practice (supplementary) measures, the requirement for new basic measures for the control of physical modifications, and other

supplementary measures, such as the improvement of guidance to enhance the ability of these mechanisms to protect, restore and improve status, was reviewed.
Within the existing legislative framework concerning TraC waters, it is considered that morphology can be adequately assessed at a project or strategic level. However, it is concluded that at present there is not adequate scope for morphology to be highlighted as a potentially significant environmental aspect or interaction i.e. for morphology to act as a 'trigger' for further environmental assessment.

Where good and high status exists, there is a priority to maintain these through the control of existing operations and future development. The Marine Morphology Study and TraC-MImAS tool can help determine the available capacity of the water bodies to further morphological change, and support the control of proposals within the existing legislative structure to prevent deterioration of status. Morphology can be affected on a wider spatial scale than Local Authority and RMBP or even national boundaries, and will therefore benefit from Integrated Coastal Zone Management and effective assessment of strategic and cumulative effects to ensure preservation of status.

Where there are existing pressures causing a water body to be at risk of reaching its required morphological status, restoration may be required. Restoration measures should be compared with current good practice and against technical feasibility and excessive costs. Once selected, the measures should be assessed through the current legislative mechanisms, which should now include morphological assessment.

Recommendations outlined include measures which are generic to TraC waters and primarily involve increasing morphology related assessment within the existing basic measures (mechanisms). On confirmation of the roles and responsibilities of governing bodies, the detailed aspects of these recommendations can be appropriately prioritised by further reviewing the current gaps identified with regard to feasibility and cost effectiveness parameters. Prior to this it is considered that the **specific inclusion of morphology** and / or ecological status as a significant environmental factor / interaction **in national guidance documents for existing mechanisms** is a cost effective method of increasing the appropriate awareness of these aspects relating to the achievement of WFD objectives.

The appropriate **consideration of the recommendations relating to existing and new basic and supplementary measures is fundamental to the effective application of the methods recommended by this study** for water body prioritisation and identification of appropriate measures.

Recommended regulatory decision support methodology for future use

The deliverables of the Marine Morphology PoMs Study and the current version of TraC-MImAS can help support Ireland's existing regulatory process for the assessment of WFD compliance relating to physical modifications.

The regulatory process for the authorisation of developments concerning physical modifications is summarised by the steps below:

Screening

This phase involves a review of the mandatory and discretionary provisions set out in legislation to determine if an Environmental Impact Statement (EIS) is required. Gaps in the current framework for such a process have been identified, and the following recommendations are made:

- Specific reference should be made within National EIS Guidance for the consideration of RBMPs, and associated objectives and programmes of measures.
- An addition should be made to the EIA Regulations for the Protected Areas provided in Annex IV of the WFD as a trigger for the assessment of significant environmental effects for sub-threshold developments.
- An addition should be made to the EIA Regulations for High Status water bodies as a trigger for the assessment of significant environmental effects for sub-threshold developments.

Pre-application discussions

The aim of these discussions should be to minimise the number of applications received by consent authorities that are either rejected for being incomplete, require amendment, or are refused for not meeting the relevant assessment criteria; whilst also creating an opportunity to promote Good Practice. The outputs from pre-application discussions should help regulators determine if more detailed regulatory assessments will be required, and if deteriorations in status will require management by considering an exemption on the basis of benefits to human health, human safety or sustainable development (Article 4 (7)).

Within this study recommendations are made for formal, consistent requests from the consent authority for information associated with RBMPs and morphology to be discussed at pre-application discussions. For example this formal request/agenda should require the applicant to come prepared with information relating to the proximity of Registered Protected Areas, High Status water bodies and existing pressures on morphological condition.

Scoping

Scoping is the process through which the key issues specific to the proposed project or receiving environment that are likely to be of significance during the Environmental Impact Assessment (EIA), are identified. It is recommended that this process be extended to sub-threshold developments.

Receipt and review of application

Following on from the pre-application discussions, the scope of the environmental report should adequately consider morphology where relevant. For the purpose of assessing compliance with the WFD in relation to morphology the following can be considered when reviewing submitted applications:

a) Potential risk to a Protected Area.
b) Likely threat to WFD objectives (TraC-MImAS).
c) Sufficient consideration of mitigation measures (Good Practice).

As demonstrated here, the deliverables of this study and the TraC-MImAS tool can help support Ireland's existing regulatory process for the assessment of WFD compliance relating to physical modifications. However, there are opportunities to refine this process through improvement to both the base data and the assessment tool.

Further development

The overall framework of TraC-MImAS is considered a valid basis on which to undertake further research and development work to provide validation of the professional judgement values and/or assumptions applied in the tool. This is the long term intention of SEPA for TraC-MImAS, and work has already commenced for the Rivers-MImAS tool.

River-MImAS, developed within the database software, Oracle, is supported in SEPA by an internal Regulation Method which defines the steps necessary to authorise an engineering activity, as well as an Operational Guide which provides SEPA staff with detailed information on the use of the rivers tool. This structured methodology aims to reduce the time required for expert judgement, by guiding staff towards screening out low risk proposals that are unlikely to threaten WFD objectives. Before such a formal regulatory procedure can be documented for use in Ireland, further technical development of TraC-MImAS, in addition to confirmation of regulatory roles and responsibilities are required. Research and development of TraC-MImAS for this purpose is continuing within SEPA, therefore it is strongly recommended that Ireland continue liaisons with this agency during this process.

The following is a summary of information provided within the Marine Morphology Study which can facilitate both the use and refinement of TraC-MImAS:

- Recommendations are made on how Irish monitoring programmes can help increase confidence in the underlying assumption of TraC-MImAS, i.e. an assessment of impacts on ecologically relevant features and processes can be used to protect morphology and ecology.
- The methods and information type and quality required for the assessment of both existing and proposed developments using TraC-MImAS are outlined.
- Recommendations for potential improvements to each of the five TraC-MImAS modules, the most prominent being that of the Typology Module are documented. To ensure a good level of confidence in the use of TraC-MImAS for regulation, a high level of confidence is firstly required in water body extents and typology.

Further field trials, monitoring results, and professional judgement across Ireland and also the UK will all benefit the refinement of the TraC-MImAS tool as well as the quality of information required for its use (e.g. refined water body typology and delineation). However, due to the nature of estuarine and coastal water bodies, TraC-MImAS, or any similar tool developed, has limited capabilities for the assessment of site specific conditions. Therefore, further development should be focused at refining this tool for its continued use in ***supporting*** regulation with the aim of **formalising a national, non-sectoral, regulatory framework which TraC-MImAS can support.**

1 INTRODUCTION AND BACKGROUND

On behalf of the Department of Environment, Heritage and Local Government (DEHLG), Cork County Council was appointed the lead authority for the South Western River Basin District (SWRBD).

Jacobs, working in association with Mott MacDonald-Pettit and RPS Consulting Engineers, have been appointed by Cork County Council to prepare a River Basin Management Plan (RBMP), including a Programme of Measures (PoMs) for the SWRBD.

The SWRBD was assigned specific Programme of Measures and Standards (PoMS) studies for completion on a national basis, one of which is 'Marine Morphology'. The aim of the Marine Morphology task is to provide a protocol to apply in the further characterisation and risk appraisal for all transitional and coastal water bodies in Ireland.

Steering Group

A Steering Group was set up to facilitate the Marine Morphology study within the Republic of Ireland. This Steering Group was chaired by the Department of Agriculture, Fisheries, and Food (DAFF) (and formerly of the Department of the Communication, Marine and Natural Resources (DCMNR)), and comprised representatives from the Environmental Protection Agency (EPA), Marine Institute (MI), National Parks and Wildlife Services (NPWS), Cork County Council, and the North-South Share Marine Morphology task team. To ensure a harmonised approach to marine morphology throughout Ireland, work undertaken has been consistent with that being carried out within Northern Ireland.

The project Steering Group consisted of the following individuals:

- Department of Agricultural, Fisheries and Food – Mr. Dick McKeever (Chairperson, 2006 – 2008)
- Cork County Council – Mr. Sean O'Breasail (Chairperson, 2008)
- National Parks and Wildlife Service – Dr. Elizabeth Sides
- Environmental Protection Agency – Dr. Shane O'Boyle
- Marine Institute – Dr. Francis O'Beirn
- RPS Consulting Engineers (NS-Share) – Helen Nutt

Both the EPA and Marine Institute were members of the UK and Ireland WFD Marine Task Team; which provided useful guidance throughout this study.

Acknowledgements

Jacobs wish to acknowledge the valuable contribution from the individuals list above and those organisations represented (including Robert Wilkes of the EPA). Jacobs would also thank the South West River Basin District project office for providing, and facilitating, access to various data resources.

The Scottish Environment Protection Agency have provide valued guidance to Ireland's morphology studies for which Jacobs would like to express their gratitude.

1.1 The Water Framework Directive & Morphology

The fundamental aim of EC Directive 2000/60/EC, the Water Framework Directive (WFD), is to maintain high ecological status (HES) of waters where it exists, prevent any deterioration in the existing ecological status of waters and achieve at least 'good' status for all waters by 2015.

Annex V of the Directive describes the quality elements that must be used for the classification of ecological status/potential for all surface water categories, and sub-divides these quality elements into the following three groups:

1. Biological elements.
2. Hydro-morphological elements supporting the biological elements.
3. Chemical and physio-chemical elements supporting the biological elements.

Table 1.1 below further defines the hydro-morphological quality elements for transitional and coastal (TraC) waters as per Annex V of the Directive.

Table 1.1: WFD Hydro-morphological quality elements

Annex V 1.1.3 Transitional Waters	Annex V 1.1.4 Coastal Waters
Tidal Regime	Tidal Regime
- Freshwater Flow	- Direction of dominant currents
- Wave Exposure	- Wave exposure
Morphological Conditions	Morphological Conditions
- Depth Variation	- Depth variation
- Quantity, structure and substrate of seabed	- Structure and substrate of the coastal bed
- Structure of intertidal zone	- Structure of the intertidal zone

The initial risk assessments completed in 2005 have shown that hydromorphology is one of the most significant pressures operating in European surface waters and therefore contributing to the failure to achieve WFD objectives. The main drivers in terms of hydromorphological risk identified by these risk assessments were hydropower, navigation, flood defence and agricultural activities (Common Implementation Strategy (CIS), 2006 (a) & (b)).

Figure 1.1 below outlines the roles of the WFD quality elements in the ecological status classification of surface water bodies. This illustration shows that the values of the hydromorphological quality elements must be taken into account when assigning water bodies to the HES class. For other status classes, the hydromorphological elements are required to have '***conditions consistent with the achievement of the values specified for the biological quality elements'*** (WFD, Annex V), i.e. if the biological quality element values relevant to good, moderate, poor or bad status/potential are achieved, then, by definition, the condition status of the hydromorphological quality elements are consistent with that achievement. This should be determined via monitoring of biological quality elements and the physico-chemical quality elements.

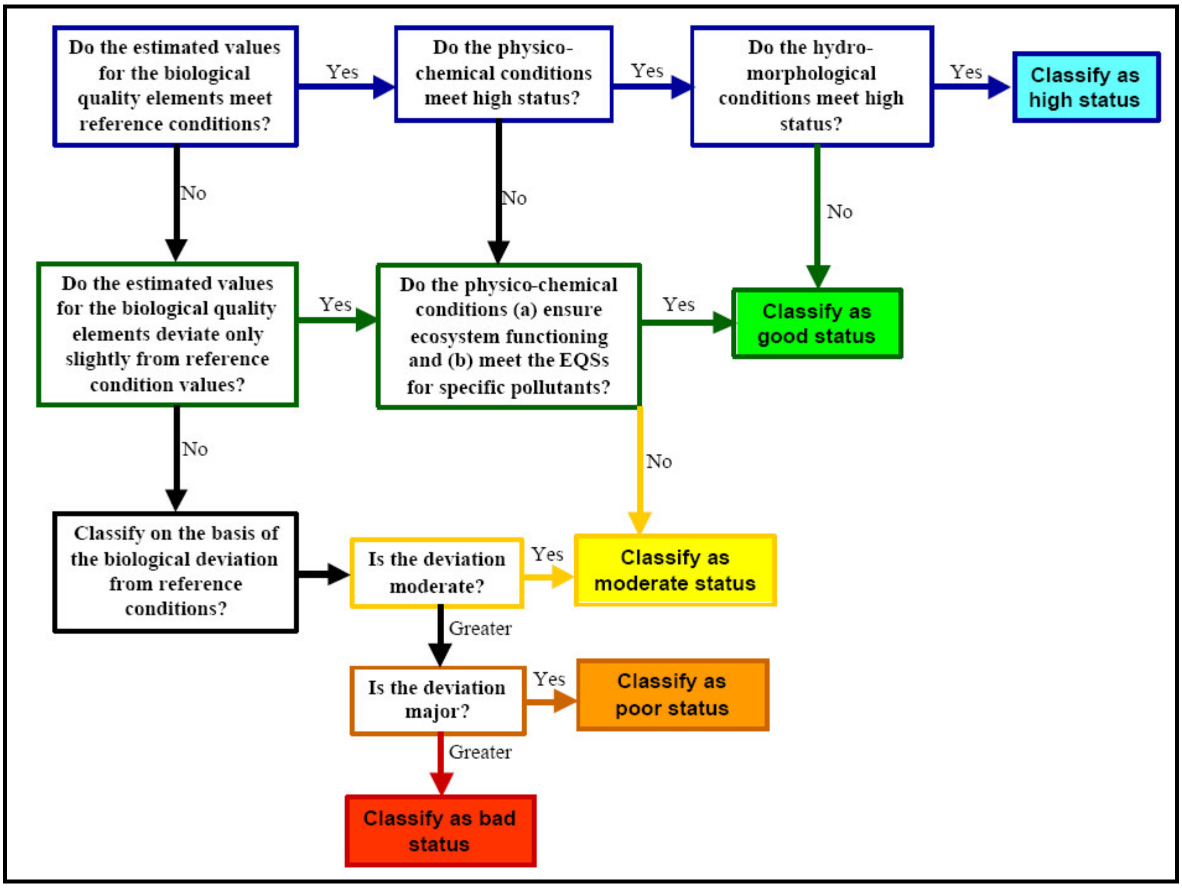


Figure 1.1: Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological status classification (reproduced from (CIS), 2004)

Under certain circumstances the WFD permits Member States to designate water bodies that have been physically altered by anthropogenic (man-made or derived) activities as artificial water bodies (AWB) and heavily modified water bodies (HMWB). The objectives for these water bodies are Maximum Ecological Potential (MEP) and Good Ecological Potential (GEP).

A HMWB is defined as

> ***"a body of surface water which as a result of physical alterations by human activity is substantially changed in character, as designated by the Member Stated in accordance with the provisions of Annex II"*** (Article 2(9))

An AWB is defined as

> ***"a body of surface water created by human activity"*** (Article 2(8))

Article 4(3) of the WFD provides for the designation of a water body as HMWB when:

- ***the changes to the hydromorphological characteristics of that body which would be necessary for achieving good ecological status (GES) would have significant adverse effects on specified uses [such as navigation or flood protection]*** (Art (4)(a)).
- ***the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option*** (Art (4)(b)).

The Directive then requires that such designation and the reasons for this be specifically mentioned in the River Basin Management Plans (RBMP) and reviewed every 6 years.

The concept of a HMWB was created to allow for the continuation of specified uses such as navigation which provide valuable social and economic benefits (but at the same time to allow for mitigation measures to improve water quality) (CIS 2003). Ireland's AWBs and HMWBs are assessed within a separate PoMS study. However, those identified as TraC HMWBs are included in this document. The WFD objectives in dealing with hydromorphology pressures are focused on prevention, restoration, and mitigation. The approach for dealing with hydromorphology pressures on the water environment (past and new developments) can be summarised as follows (CIS, 2006 (a):

Prevention:

> ***For new developments there is a need to first prevent deterioration of water body 'status', and where this is not possible, mitigation measures should be applied (Article 4(7)).***

Restoration:

> ***Where a physical modification has already taken place, actions should first be considered to restore the water body with the aim to achieve GES.***

Mitigation:

> ***Where restoration is not possible, mitigation measures should be investigated with the aim to meet GEP.***

1.2 Initial Risk Assessment

In accordance with Article 5 and Annex II of the WFD, an initial risk assessment was undertaken across Ireland and reported to the European Commission (EC) in March 2005. The purpose of this risk assessment was to assess the susceptibility of surface water status to the pressures identified and also to determine the likelihood of water bodies failing to meet the Article 4 environmental quality objectives. This risk assessment included the identification and assessment of a number of anthropogenic pressures that have the potential to impact on the morphological quality elements:

- Dredging
- Disposal of dredge spoil
- Coastal defence
- Flood protection
- Embankments
- Built structures
  - Ports/Harbours
  - Urbanisation
  - Industrial/Power station intakes
- Intensive land use (ILU) (transitional water bodies only)

Each TraC water body was assigned a risk category based on the proportion of the water body altered by human activities. The initial risk assessments were based on screening or semi-quantitative assessments; therefore, to help reflect confidence in the assessments a four-category risk scheme was adopted. Where information was either lacking or of low confidence, the water body was assigned to either the 'probably at risk' or 'probably not a risk' category.

1a – at risk

1b – probably at risk

2a – probably not at risk

2b – not at risk

Results

The initial risk assessments concluded that 35% of transitional water bodies, and 18% of coastal water bodies within the Republic of Ireland (RoI) were ***'at risk'*** or ***'probably at risk'*** of failing to meet the WFD objective of Good Status due to physical alteration.

Figures 1.2 and 1.3 below highlight the proportion of TraC water bodies identified by the initial risk assessments as being significantly at risk (1a and 1b) of failing the WFD objective of Good Status due to pressures on morphology for each River Basin District (RBD).

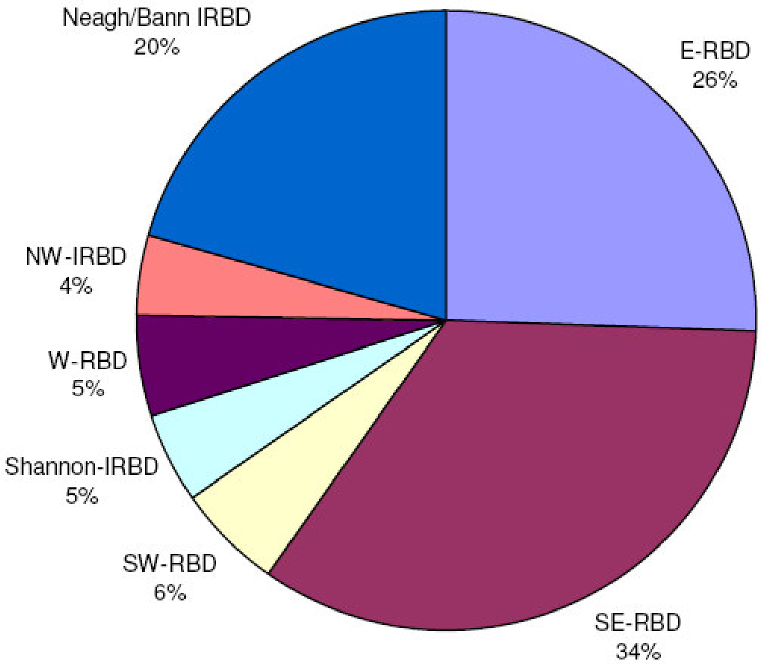


Figure 1.2: % of Coastal Water Bodies 'at risk' or 'probably at risk' from Morphology

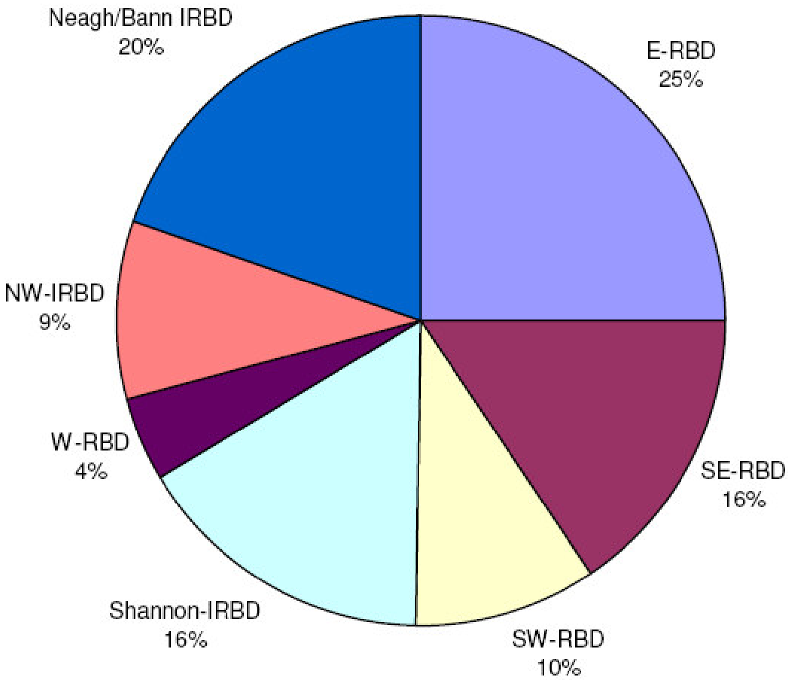


Figure 1.3: % of Transitional Water Bodies 'at risk' or 'probably at risk' from Morphology

Figures 1.4 and 1.5 below show the percentage distribution of morphological pressure types identified by the initial risk assessments as likely to result in failure of the WFD objectives in TraC waters.

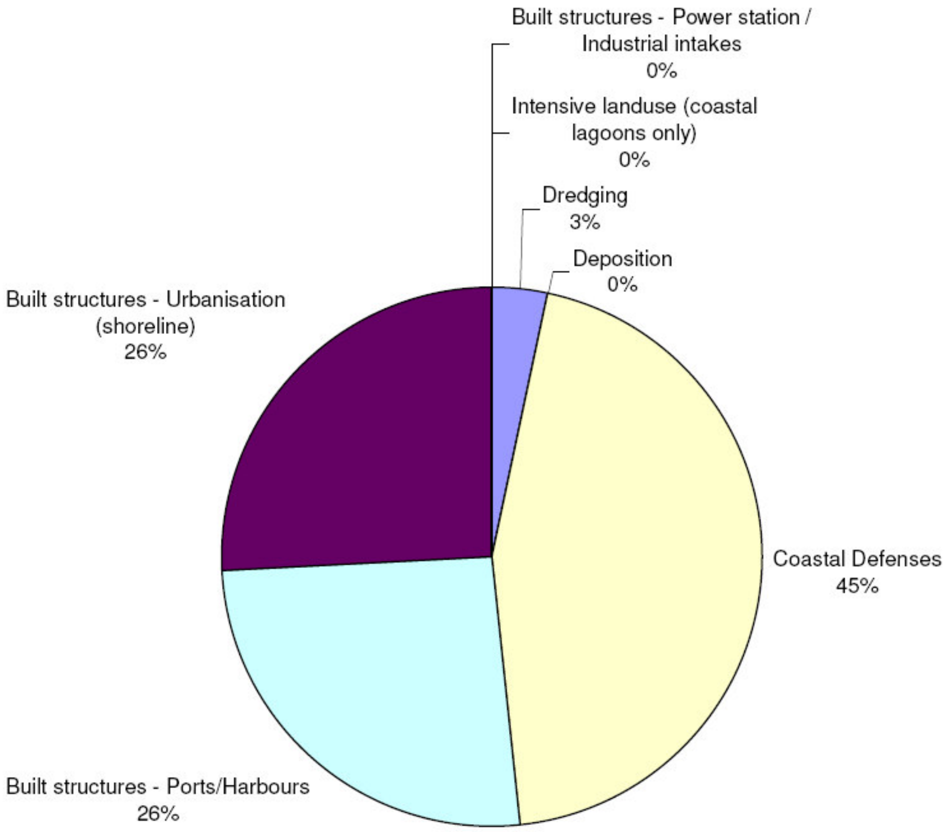


Figure 1.4: % Distribution of Morphology Pressures – Coastal Waters

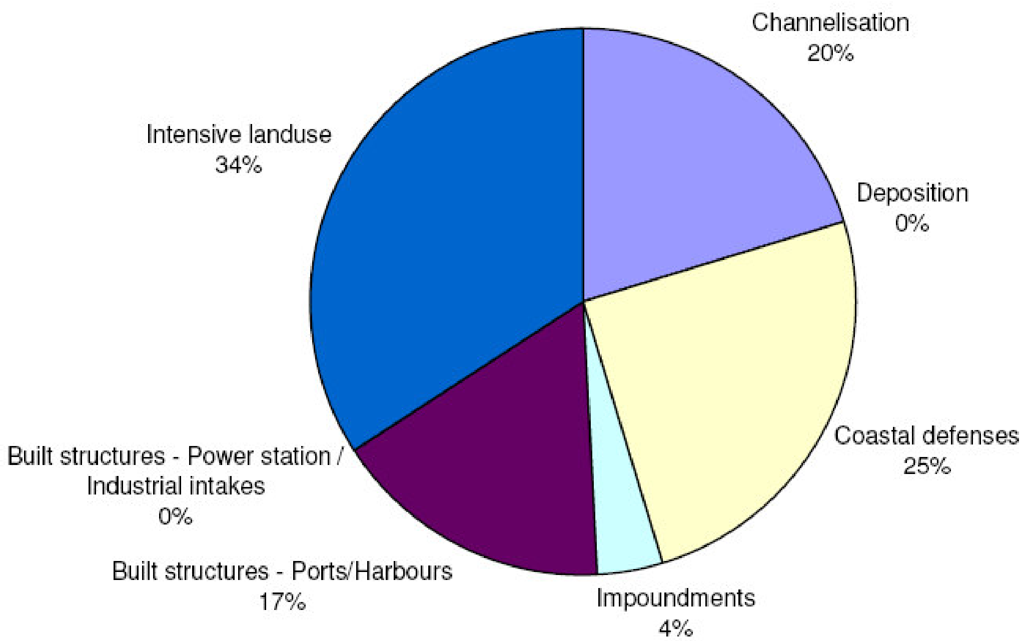


Figure 1.5: % Distribution of Morphology Pressures – Transitional Waters

Transitional waters were identified as being most at risk from ILU, channelisation; and coastal defences, whereas the risk to coastal waters was found to be attributed to the physical pressures including coastal defence, ports/harbours and urbanisation.

Conclusions of Initial Risk Assessment

Annex II of the WFD requires that further characterisation shall, where relevant, be carried out for those bodies identified as being at risk of failing the environmental quality objectives in order to optimise the design of both the monitoring programmes and the PoMs.

As the initial characterisation was based on screening or semi-quantitative assessments, it was concluded that surface waters would require more detailed assessments in order to re-characterise risk so as to report a two-category risk scheme, and then facilitate the development of tools for the management of these water bodies.

1.3 Overall Approach – Marine Morphology PoMs Study

The Marine Morphology PoMs Study aims to provide a protocol to apply in the further characterisation and risk appraisal for morphology in TraC waters, the outcomes of which will contribute to the development of a tool aimed at supporting the assessment and management of morphology in these water bodies.

The objectives of the study are as follows:

- Establish the relationship between morphology characteristics and biological status;
- Identify what level of morphological pressure is “sustainable” within a water body;
- Establish which morphological indicators should be included in TraC monitoring programmes;
- Identify water bodies where morphology restoration measures are required (linked to HMWB designation process);
- Identify the available buffer (or capacity) of water bodies in order to prioritise action levels;
- Prioritise morphology pressures; and
- Develop a decision support tool for regulators to assess the potential impact of future developments on individual water bodies (i.e. to prioritise activities and establish a tiered assessment system).

This study involves all TraC water bodies within the RoI, but was undertaken in parallel to the North-South Share (NS-Share) project to ensure compatibility of methodologies between Northern Ireland (NI) and the RoI.

The Marine Morphology study involves a total of 309 water bodies; 113 coastal water bodies (4 of which border with NI - Portstewart Bay, Mourne Coast, Lough Foyle and Carlingford Lough) and 196 transitional water bodies (4 of which border with NI - Foyle and Faughan Estuaries, Newry Estuary, Carlingford Lagoons and Shilities Loughs) within the RoI.

Figures 1.6 below illustrates the water bodies ‘typed’ as transitional or coastal for the purpose of the WFD. The risk categories assigned to each of these water bodies are shown in Figure 1.7.

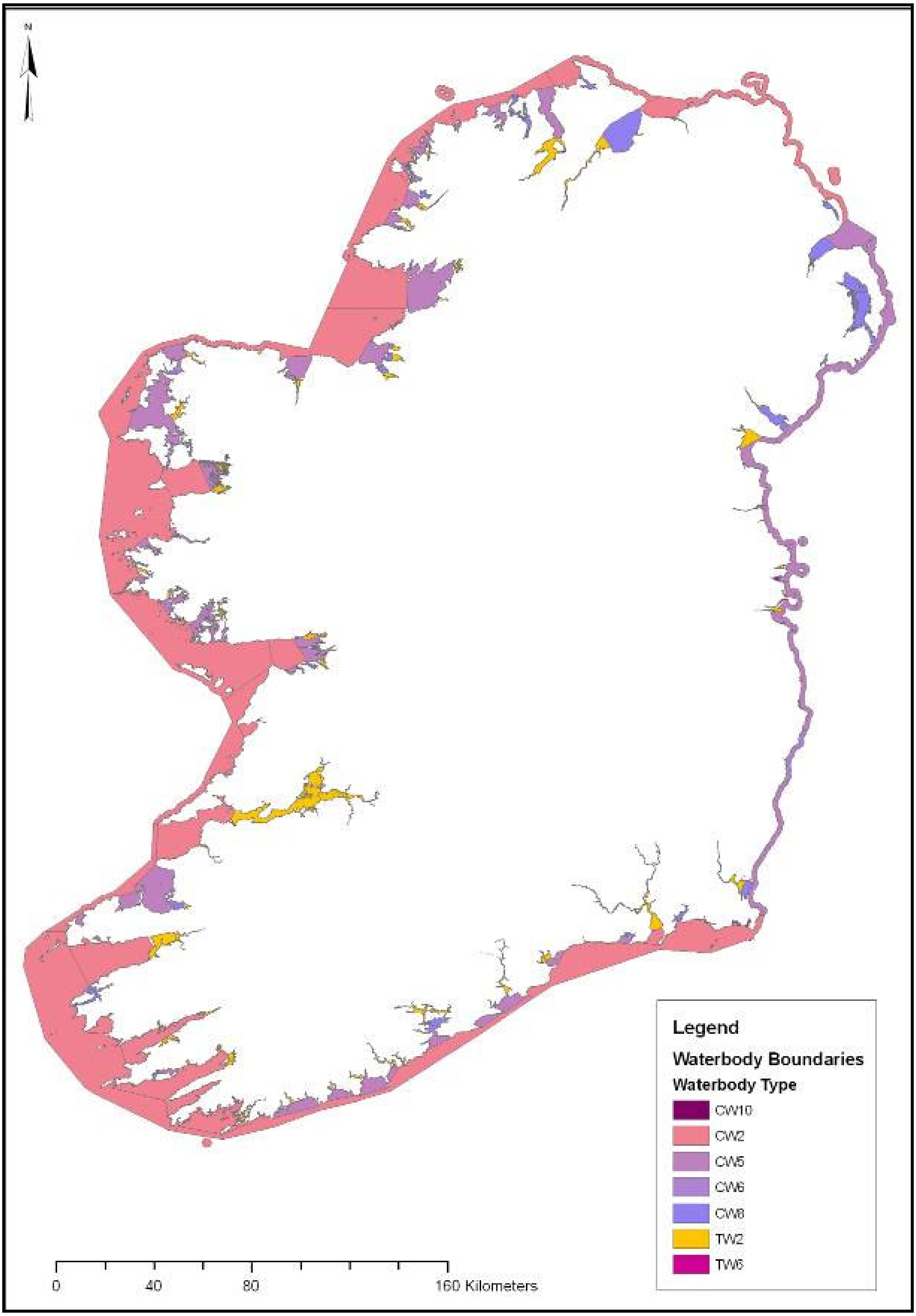


Figure 1.6: TraC water body types

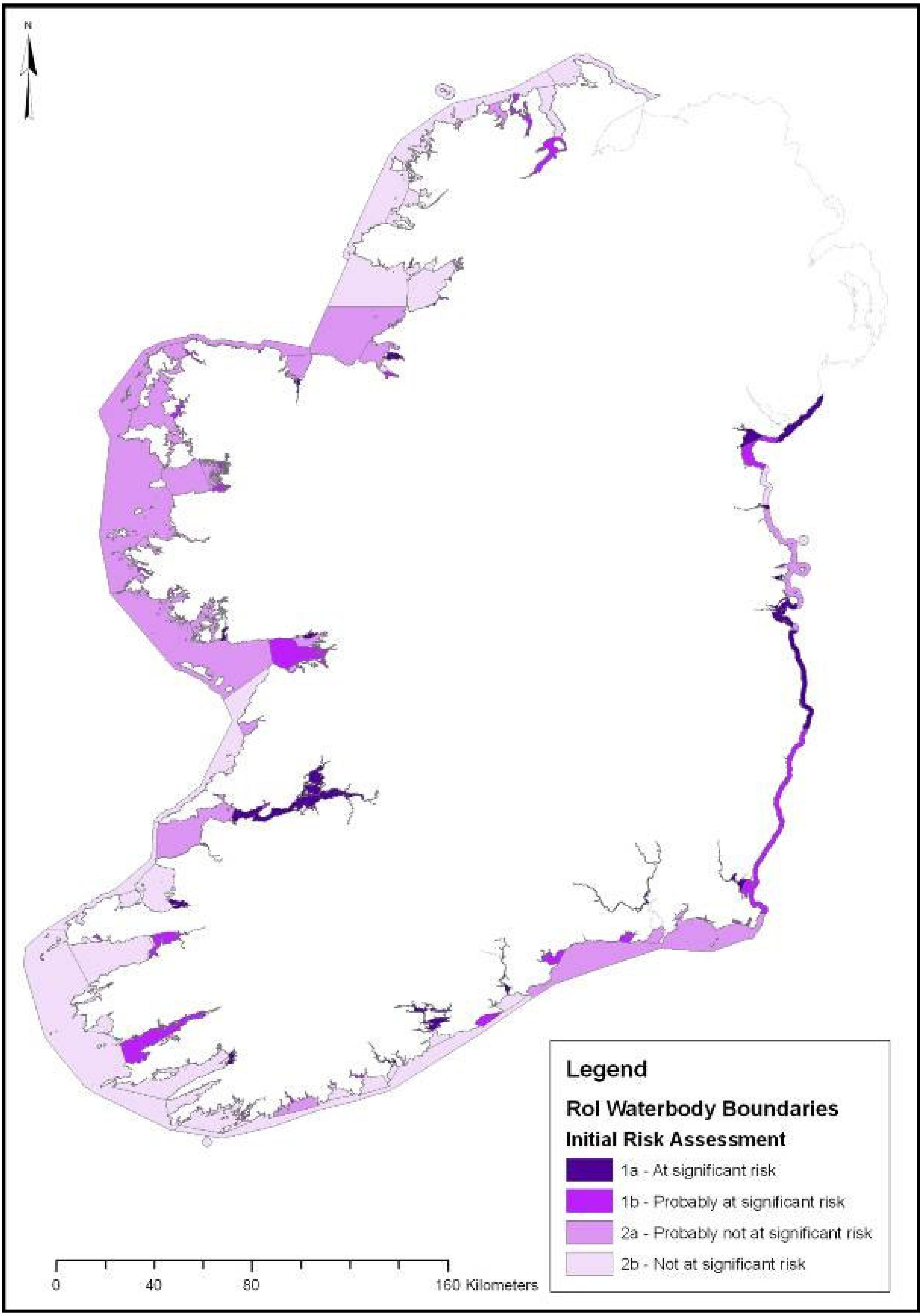


Figure 1.7: Initial risk categories assigned to TraC water bodies

Following on from the initial risk assessments; the further characterisation and risk appraisal of morphology in TraC waters are proposed to investigate the uncertainty concerning the designation of water bodies at risk of failing to meet good status. The designation of risk categories should be based on the relationship between a pressure and the impact on the morphological attributes of a water body; therefore, it was proposed to investigate this relationship using scientific methods, historical data and also the results of the monitoring programme.

The Marine Morphology Study was progressed under the following tasks:

- Literature Review
- Data Review / Data gaps
- Review of Monitoring Systems
- Improve Definition of Pressures on Receptors
- Assess Ecological Impacts of Pressures
- Develop Assessment Tool
- Prepare Final Report on National Methodology

1.4 Report Structure

The following is a summary of the work undertaken to meet the objectives set out in section 1.3 above. A key aim of this study was to further characterise the risk to the morphology of TraC waters. The classification of TraC water bodies, however, was outside the scope of this study.

Chapter 2 provides a brief summary of the Literature Review undertaken on commencement of this study. This review is documented in full in Appendix 2-1.

Chapter 3 summarises the initial Data Review undertaken on commencement of this study (Appendix 3-1). The data findings on completion of a final data review are then detailed by outlining the pressures identified for assessment and the methods used to further characterise these pressures. Recommendations for further data requirements and improvements are then made.

Chapter 4 summarises the existing monitoring systems for Irish TraC waters and their relevance to the monitoring of morphological attributes.

Chapter 5 outlines the approach taken by this study to assess the potential impact of identified pressures on morphological attributes. The current understanding of the relationship between morphology and ecology in the context of the WFD is outlined and the Morphological Impact Assessment System (MImAS), developed by the SEPA, is introduced by including reference to Irish trials undertaken during the development of this system. To outline how MImAS and the deliverables of this study can be used for the purpose of further characterising risk an example using the transitional water body Clonakilty Harbour (SW_100_0100) is provided.

Chapter 6 sets out the method applied to further characterise the risk of TraC water bodies failing to meet the WFD objectives and summarises results for each water body assessed. MImAS assessment was focused on 122 TraC water bodies identified by this study as those which required further characterisation in relation to morphology, for example those water bodies characterised as 'probably at risk' or 'probably not at risk' in the initial risk assessments. For those water bodies further characterised as at risk, Water Body Summary Sheets detailing the physical characteristics, ecology and pressures identified were produced and are provided in Appendix 6-4.

Chapter 7 brings together existing information on 'good practice measures' for activities which involve hydromorphological alterations to TraC waters. The accompanying interactive spreadsheet (Appendix 7-1) guides the user to sources of information which can aid decisions for identifying measures that aim to prevent deterioration in ecological status for new developments, or to identify measures to address existing modifications that will enable a water body to achieve its environmental objective under the WFD.

Chapter 8 documents a review of potential future pressures on the morphology of Irish TraC waters. This projection of future risks to the achievement of the WFD objectives is not site specific, but provides a qualitative assessment of the main drivers potentially affecting Irish TraC waters.

Chapter 9 follows on from Chapter 4 by outlining recommendations for future monitoring of morphology in Irish TraC waters.

Chapter 10 collates the information set out in the previous chapters to develop appropriate recommendations for the design of programmes of measures relating to morphology with the aim of achieving the WFD objectives by 2015. To identify the existing basic measures governing Irish transitional and coastal water bodies a summary of a review of relevant legislation is outlined. Methods for the prioritisation of TraC water bodies suitable for the assessment of appropriate measures are then recommended. Recommendations made in this chapter are generic and are not outlined specifically for each prioritised water body. Appendix 11-1 tabulates a summary of proposed measures identified as relevant for marine morphology. This appendix should be read in conjunction with both Chapters 10 and 11.

Chapter 11 outlines how the deliverables of the Marine Morphology PoMs Study can assist the regulation of future physical modifications of Ireland's TraC waters with the aim of achieving WFD objectives. An example, in the form of a proposed harbour development, is provided to demonstrate how MImAS, in conjunction with the deliverables of this study, can be used as a regulatory decision support tool.

2 LITERATURE REVIEW

2.1 Introduction

An initial step in achieving the objectives of the Marine Morphology study was to complete a Literature Review. This review aimed to investigate and report on relevant approaches under development for the assessment of anthropogenic activities and morphology, identify current research underway into the relationship between morphology and ecology, and identify the availability and applicability of any literature and guidance for the development of an appropriate assessment methodology for the purpose of the WFD. This Literature Review is outlined in full in Appendix 2-1 and details all references reviewed for the purpose of this report. This chapter aims to summarise the findings of this Literature Review, and where relevant references to chapters within this review are provided.

The Literature Review has concluded that the most common, and in most cases necessary, approach to assessing and reporting the impact of morphological pressures on ecology involves a mixture of qualitative and quantitative assessments (Chapter 7 of Appendix 2-1). Although it is clear that many anthropogenic activities which result in pressures to morphology have some impact on ecology, it was concluded that there is limited quantitative data throughout Europe describing the relationships between morphological conditions and ecological health (Chapter 8 of Appendix 2-1). This is reflected by the recognition of the CIS Hydromorphology Group recognise that “in many cases knowledge is insufficient to assess or model precisely the impacts of hydromorphological alterations on the biological quality elements” and “mitigating measure involving physical modifications” (CIS, 2006 (b)).

The three projects identified as potentially providing the most useful information for developing a protocol for further characterisation and risk appraisal were the Joint Nature Conservation Committee’s (JNCC) ‘Irish Sea Pilot’, the United Kingdom (UK) Marine Biological Association’s Marine Life Information Network (***MarLIN***) project, and an European Union (EU) Interreg project titled ‘Sensitivity and Mapping of Inshore Marine Biotopes in the Southern Irish Sea’ (SensMap); all of which are introduced in chapter 4 of the Literature Review. All three projects required the input of very detailed information on the type and extent of habitats (including species), which is currently unavailable for Ireland. However, the overall approach used by these projects matched that being progressed by this study, i.e. the Source, Pathway, Receptor model, or as defined by the CIS working group IMPRESS; the DPSIR framework (Driver, Pressure, State, Impact, Response). This overall approach was carried forward to the development and application of MImAS which is discussed further below and in Chapter 5 of this report.

At present there are no quantitative environmental standards available to assess the ecological impacts of alterations to the morphology of TraC waters, and where regulation exists, decisions are principally made on a case by case basis, using a combination of field data and expert judgement. However, from a review of the projects noted above, the Literature Review identified environmental factors that can potentially be used to assess the sensitivity of marine species. Those factors of most relevance to morphology (and hydromorphology) include:

- Substratum loss
- Smothering
- Suspended sediment
- Desiccation
- Changes in emergence regime
- Changes in water flow rate
- Changes in wave exposure
- Physical disturbance/abrasion
- Displacement

In assessing sensitivity both ***MarLIN*** and SensMap concluded that the effects of an activity and resultant changes in morphological [and other] factors are site specific and cannot be generalised. Therefore, to enable some form of generic assessment of the sensitivity of coastal ecology to various pressures both projects used 'benchmarks' in order to report sensitivity to a 'specified change in an environmental factor'.

Following direction from the DEHLG, the Marine Morphology Study is being applied nationally. On completion of the Literature Review, it was concluded that the extent of information required for the assessment methods outlined by the studies researched is not available nationally for Irish TraC waters at present. Therefore, the assessment of risk to water bodies in Ireland requires a generic method that can be applied nationally but can also be used to focus assessment where site specific assessments are required.

The conclusions drawn by the Literature Review led to the consideration of the Transitional and Coastal Morphological Impact Assessment System (TraC-MImAS) for use in the Marine Morphology study. This tool was being developed by the Scottish Environmental Protection Agency (SEPA) and the United Kingdom Technical Advisory Group (UKTAG) in response to the absence of suitable data to empirically derive standards for morphological conditions. As reported in Annex I of the Literature Review (Appendix 2-1), TraC-MImAS was developed with the intention to assist regulators in determining if changes to morphology could pose a risk to ecology, and thereby identify those proposals that could threaten the WFD aim of achieving GES (through further characterisation of risk), or result in a deterioration in ecological status (relevant to the PoMs). Further development of this tool continued following the Literature Review.

The TraC-MImAS tool is not intended to provide a detailed assessment of ecological status, but rather provide a means of identifying where ecological conditions are likely to be impaired through impacts to morphology, i.e. it is based on the assumption that an assessment of impacts on ecologically relevant features and processes can be used to protect morphology and ecology.

The tool uses a concept of 'system capacity' to measure impacts to morphological conditions, assuming that completely pristine TraC waters have a measure of assimilative 'capacity', which can be degraded by anthropogenic activities. TraC-MImAS comprises of 5 modules which combine to estimate the existing system capacity (%) of a water body (see Figure 2.1 below).

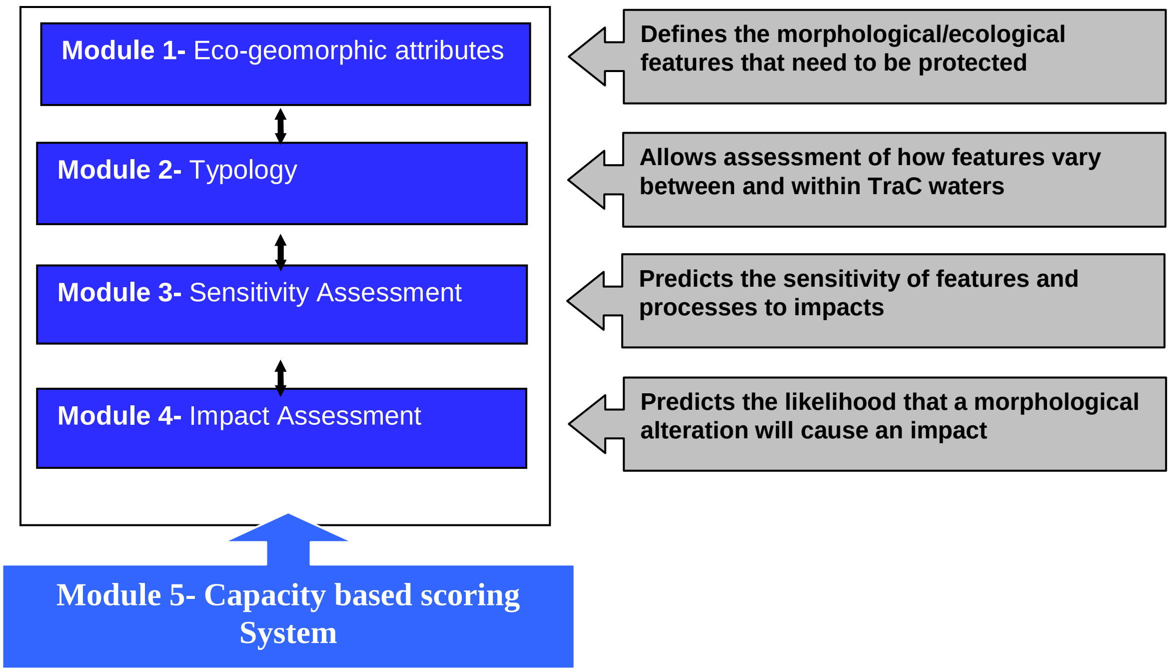


Figure 2.1: Overview of MImAS Modular Components (extract from SEPA, 2007a)

TraC-MImAS is considered suitable as both a generic and focused assessment tool which can be applied nationally to assist further characterisation and risk appraisal. The use of TraC-MImAS for specific assessments however would benefit greatly from the incorporation of monitoring results.

The pressures considered by TraC-MImAS were reviewed throughout the development of this tool. An addition to the original scope of these pressures was requested by Ireland (SWRBD and NS-Share Marine Morphology teams) via the UKTAG Technical Panel to represent aquaculture activities. This resulted in the pressure type 'Other Disturbances to Seabed'. Table 2.1 below outlines the full suite of pressures that can be assessed within TraC-MImAS and that have received approval from the Marine Morphology Steering Group.

Table 2.1: Morphological alterations considered within TraC-MImAS (extract from SEPA, 2007a)

Morphological Alteration	*Description*
Land and channel alteration	
Land claim- High impact	Recent or proposed enclosure of intertidal or subtidal areas within impermeable banks followed by infilling for use by agriculture, housing, port or industry. Also used for land claim that has taken place in the past and is still deemed to be having a significant impact.
Land claim- Low impact	Historic (e.g. >50yrs ago) enclosure of intertidal or subtidal areas within impermeable banks followed by infilling for use by agriculture, housing, port or industry. Can also be used for more recent land claim where the impacts are minimal or where the surrounding environment has partly recovered natural habitats and features.
Tidal channel realignment- High impact	Recent or proposed realignment of a tidal channel. Also used for realignments that have taken place in the past and is still deemed to be having a significant impact.
Tidal channel realignment- Low impact	Low impact alterations to course or planform of upper estuaries where the channel remains river-like. Includes straightening and removal of meanders to increase channel gradient and flow velocity. Typically used to cover historic work (e.g. >50yrs ago) and where the channel has partly recovered natural habitats and features.
Sediment manipulation	
Dredging- High Impact	The excavation of sediments where there is likely to be considerable damage caused to seabed environment, both within and out with the area dredged. Typically reserved for situations where dredging has not taken place in the past or where dredging has taken place within the last 10 years and impacts are still likely to be present. Typically reserved for situations where sediments are removed to a depth of greater than 1m.
Dredging- Low impact	The excavation of sediments where the damage is likely to be restricted to the area being dredged. May be used for capital dredging where the impacts are likely to short lived or are being minimised through the use of best practice. Could also be used to capture areas that have been dredged in the past and where there is evidence that some impacts still exist. Some forms of trawling could be captured under this category.
Other alterations to bed substrate	Any other temporary disturbances to bed morphology or substrate character where the impacts are likely to be remain restricted to the area of bed directly disturbed and where the bed is likely to recover significantly over time. Could include some forms of trawling.
Disposal of dredged materials	The deposit of dredged material onto intertidal and subtidal areas for the purposes of disposal.
Flow/sediment altering structures	
Piled Structures	A range of structures raised on one or more foundation structures extending out into the adjacent water body e.g. bridge and pier supports. This category also includes wind turbine monopiles.
Flow/sediment manipulation structures	Hard engineering structures built to stabilise waterways for navigation or counter the effects of longshore drift. These include breakwaters, piers, groynes, flow deflectors, training walls etc.
Impounding structures	A temporary (e.g. barrage) or permanent structure that extends across a channel that is used to impound measure or alter flow (e.g. weirs, sluices).
Causeway	A physical barrier projecting from the shore whose foundations extend to the bed and where gaps in the foundations represent < 20% of the total length. Typically used to support transport routes.
Shoreline alterations	
Shoreline reinforcement – High Impact	The use of consolidated materials, e.g. rock armour, revetments, retaining walls, gabion baskets, seawalls, wharves, sheet piling etc. to protect vulnerable coastlines or harbours from erosion. Refers to situations were the reinforcement is having a persistent influence over the intertidal or subtidal zone.
Shoreline reinforcement – Low impact	Stabilisation of the shoreline using beach material to maintain beach levels and dimensions. May include use of synthetic materials. Also includes other forms of low impact shoreline protection, for instance protection that is set back and does not have a persistent influence over the intertidal or subtidal zones.
Flood defence embankment	An artificial bank of earth or stone created to prevent inundation of estuarine and coastal floodplains.

As noted throughout the Literature Review and reflected by this study, the study Steering Group, and the UKTAG; the results of the WFD monitoring programmes are fundamental to the further development of such assessment tools. The WFD required monitoring programmes for all surface (and ground) waters to be in place by December 2006, the results of which would assist the further characterisation of water bodies as well as focus the classification of these waters.

The UK & Ireland Marine Task Team have progressed the work outlined in Section 4.11 of the appended Literature Review (Appendix 2-1) to develop classification tools for TraC waters. However, this work is still outstanding for those tools relevant to hydromorphology classification. In Ireland, both the Environmental Protection Agency (EPA) and the Marine Institute (MI) were identified as the responsible bodies for the WFD monitoring programmes in TraC waters. However, the regulatory system for coastal development and activities in Ireland has changed slightly from that documented in the Literature Review. Following the general elections held in May 2007 various responsibilities relating to coastal waters were transferred between government departments. This resulted in the formation of the new DAFF (formerly the Department of Agriculture and Food, transferred under S.I No. 705/2007) to which certain functions of the former DCMNR under the Foreshore Acts (1933 – 1998) have been transferred. The DCMNR is now altered to the Department of Communications, Energy and Natural Resources (DCENR) (S.I No 706/2007). Ireland's regulatory system for coastal development and activities is discussed further in Chapter 11 of this report.

The Literature Review further investigated the pressures assessed in the initial risk assessments (as set out in Section 1.2 of this report), and noted that the assessment of aquaculture as a pressure was outside the scope of the Marine Morphology Study (following direction from the DEHLG a specific PoMS study was not progressed).

A review of existing coastal mathematical models (primarily hydrodynamic and water quality) and existing transitional water models (hydrodynamic/ water quality/ nutrients/ ecological) was undertaken as part of the Literature Review to help identify any relevance and potential use / benefit relevant to the assessment of marine morphology. Questionnaires were issued to organisations known or thought to have been involved in the development and application of relevant models covering TraC waters. The full database of models collected is shown in Appendix IV of the Literature Review (Appendix 2-1). Using the information provided by the questionnaires, water body codes were assigned to each model. Table 2.2 below is an extract of the marine model database showing the coverage of models across RBDs in Ireland. The details of these models should prove useful to the classification of TraC water bodies.

Table 2.2: Summary of existing coastal and transitional water models mathematical models identified

A Model Identification and General Details					B Model Categories (tick as appropriate)				C Geographical Extent (give details for each component model)	
Model name	Date of model development	Available	Is model coastal or estuarine or both	Purpose of the study	Coastal processes (hydrodynamic, wave, sediment movement)	Coastal defence (hydrodynamic, wave)	Effluent dispersal (hydrodynamic, Effluent dispersion, advection dispersal, partical tracking)	Water Quality	Extent of modelled area	Water Body
Drogheda, Co Louth	1997	Limited	Both	EIS for proposed capital dredging scheme	x	x			River Boyne, Drogheda, Co Louth	
Laytown, Co Meath	2004 - 2005	Limited	Both	Feasibility study for proposed beach renourishment	x	x			Coastline between laytown and Bettystown, Co Meath	EA_010_0100
Bray, Co Wicklow - Coastal Defence		Limited	Both	Environmental impact modelling	x	x			Bray Harbour	
Co Meath coastline	1998	Limited	Both	Coastal zone study	x				Co Meath coastline - 21 km	
Boyne Estuary and Environs		Limited	Both	Coastal hydraulic study	x				Boyne Estuary and River Boyne navigable channel	
Drogheda, Co Louth	2000	Limited	Both	EIS for the turning vee on the River Boyne, Drogheda, Co Louth	x				River Boyne, Drogheda, Co Louth	
The Burrow Portrane, Co Dublin	1997	Limited	Both	Coastal zone study	x				The Burrow, Portrane	EA_020_0000, EA_050_0100
Dublin Bay	2002	Commercial	Both	Assessment of the hydrodynamic regime in Dublin Bay	x		x	x	Dublin Bay - associated jpeg	EA_090_0000
Greystones Harbour	2000	Limited	Both	Hydraulic modelling study	x				Greystones Harbour	EA_100_0000
ARKLOW-EC	2004 - 2005	With certain conditions	Coastal	Study on the sediment movement and water quality in the region	x			x	52.697 - 52.90 N, 6.00 - 6.20 W	EA_150_0100
Portrane	2006	Y	Both	Environmental impact assessment of discharge from an outfall	x		x	x	Portrane	EA_020_0000
Malahide Inlet/Broadmeadow Estuary		Limited	Both	Investigate the hydrodynamic regime					Malahide Inlet/Broadmeadow Estuary	EA_060_0100, EA_060_0000
Bray Harbour	2002 - 2004	Limited	Both	Bray Harbour Feasibility Study					Bray Harbour	EA_110_0100
Irish Sea	2003	Commercial	Coastal	Investigation of scallop larvae populations off southeast coast of Ireland	x		x		Irish Sea	ERBD & SERBD
Irish Sea Model	2005	Commercial	Coastal	Morphodynamic modelling of the Irish Sea	x		x		Irish Sea	ERBD & SERBD
Irish Sea Model 3d	2005	Y	Coastal	To examine the distribution of seed mussel larvae along the eastern Irish coast	x		x	x	The entire Irish Sea	ERBD & SERBD
Irish Sea Model	2001	License based	Coastal	To derive boundary conditions for coastal and estuarine hydrodynamic models in UK	x		x	x	The entire Irish Sea	ERBD & SERBD
Courtown, Co Wexford Coastal Protection Scheme	2005	Limited	Both	Coastal erosion study	x	x			Courtown Beach	
Courtown/Ardamine Study	1997	Limited	Both	Coastal regime study of active beach	x				Courtown Beach/Ardamine Beach	SE_010_0000
Wexford Harbour	2002	Commercial	Both	Measuring and modelling of nutrient dluxes in brackish waters	x		x	x	Wexford Harbour - associated jpeg	SE_040_0000, SE_040_0200
Rosslare/Wexford Harbour Coastal Erosion Study	2001	Limited	Both	Coastal erosion study	x				Wexford Harbour and Rosslare Point	SE_045_0000, SE_040_0200, SE_040_0000, SE_010_0000
South East ROMS		Restricted	Coastal	Physical climate, HAB prediction, single bay management	x		x	x	St Georges Channel, Eastern Celtic Sea, Southern Irish Sea	SE_050_0000
ROMS (Regional Modelling System)	Subject to permanent advancement	Y	Both	To develop a simulation and forecasting system for marine ecosystem dynamics in strategic areas of Irish waters	x				Celtic Seas, NE Atlantic	SE_050_0000, SW_010_0000
Bannow Bay	2004	Commercial	Estuarine	INTERREG IIIA project "Sustainable Management of Aquaculture, Recreation and Tourism: SMART"	x		x	x	Bannow Bay - associated jpeg	SE_090_0000
Dunmore East, Co Waterford	2005	Limited	Both	EIS for proposed harbour development	x			x	Dunmore East Harbour, Waterford Estuary	SE_100_0000
Waterford Harbour	In development	Commercial	Both		x		x	x	Currently under development	SE_100_0000, SE_100_0150, SE_100_0500
River Barrow Numerical Model Ref	1993		Estuarine		x				River Barrow from New Ross to the Junction with the River Suir	SE_100_0200
Rosslare Harbour	2006	Y	Both	To examine sediment transport from a dump site off the Wexford coast	x		x	x	Rosslare and Wexford Harbours	SE_045_0000
Doonbeg, Co Clare	2000	Limited	Both	Coastal processes study	x	x			Doughmore Bay	SH_080_0100
Liscannor Bay, Co Clare	1995	Limited	Both	Assessment of coastal processes	x	x			Liscannor Bay, Co Clare	SH_100_0000
Shannon Estuary Oil Spill Model	1997 - 2001	N	Estuarine	Tracking oil movement on water and transferring details on to a GIS model	x				Shannon Estuary from Limerick to Loop Head/Kerry Head	SH_060_0800, SH_060_0300, SH_060_1100
Shannon Dredge Disposal	2002	Y	Estuarine	To examine dredge disposal sites at various points in the Shannon Estuary	x				Various locations within Shannon Estuary	SH_060_0800, SH_060_0300, SH_060_1100
Cork Harbour	2002	Commercial	Both	Measuring and modelling of nutrient dluxes in brackish waters	x		x	x	Cork Harbour - associated jpeg	
Cork Harbour	2004	Commercial	Both	Environmental impact assessment for Carrigrennan treatment works	x		x	x	Cork Harbour - associated jpeg	
Cork Harbour	2005	Commercial	Both	Modelling caustic soda spillage in Cork Harbour	x		x	x	Cork Harbour - associated jpeg	
Cobh Harbour	2004 - 2005	Limited	Both	Modelling of the fate of dredged material	x				Cobh Harbour	
Ringaskiddy	2005 - ongoing	Limited	Both	Impact of port development on coastal processes	x				Ringaskiddy	SW_060_0000
Kinsale Harbour	2004	Commercial	Both	Modelling industrial discharges from Eli Lily	x		x	?	Kinsale harbour - associated jpeg	SW_080_0000
North Harbour, Clear Island	2002	Limited	Both	Hydrodynamic study	x				North Harbour, Clear Island	SW_140_0000
Bantry Bay and Dunmanus Bay	2005	Commercial	Both	Assessment of dredge spoil disposal in Castletownbere	x		?	?	Bantry Bay - associated jpeg	SW_160_0000, SW_170_0000, SW_170_0100
Kenmare Bay	1999	Commercial	Both	Environmental impact assessment of aquaculture operations	x		x	?	Kenmare Bay - associated jpeg	SW_190_0000, SW_190_0300
Knights Town Harbour, Valentia Island, Co Kerry	2004 - 2005	Limited	Both	Hydrodynamic study for proposed harbour upgrade	x				Knights Town Harbour, Valentia Island, Co Kerry, Portmagee Channel,	SW_220_0000
Cromane, Co Kerry	2003	Limited	Both	Hydrodynamic study	x				Cromane, Co Kerry	SW_230_0100
Dingle Bay	2002	Commercial	Both	Modelling scallop larvae transport pathways in Dingle Bay	x		?	?	Dingle Bay - associated jpeg	SW_240_0000
Youghal Harbour	2005	Y	Both	To examine the effects of discharging various chemicals into Youghal Harbour	x		x	x	Youghal Harbour	SW_020_0100
Kenmare Bay	1999	Y	Both	To assess the impact of aquaculture activities in Kenmare Bay	x		x	x	Kenmare Bay and River to the east of the given coordinates	SW_190_0000, SW_190_0300
Greencastle Harbour, Co. Donegal		Limited	Both	Hydrodynamic study for proposed harbour development	x				Greencastle Harbour, Co. Donegal	NB_010_0000
Port Oriel, Clogherhead, Co Louth	2003	Limited	Coastal	Coastal processes study for pier upgrade/extension	x				Clogher Head, Co Louth	NB_025_0000
Annagassan, Co Louth	2000	Limited	Both	Coastal processes study	x				Annagassan on the southern shores of Dundalk Bay, Co. Louth	NB_040_0000
Carlingford Lough	2006	Limited	Both						Carlingford Lough	NB_030_0000
RoMS (Regional Modelling System)	2004	Y	Both	To examine the environmental impact of discharge from an outfall	x		x	x	Dundalk Bay with a tidal boundary extending from Cooley Point on the north side to Dimany Point on the south side	NB_040_0100, NB_040_0300

Table 2.2 (continued): Summary of existing coastal and transitional water models mathematical models identified

Model name	Date of model development	Available	Is model coastal or estuarine or both	Purpose of the study	Coastal processes (hydrodynamic, wave, sediment movement)	Coastal defence (hydrodynamic, wave)	Effluent dispersal (hydrodynamic, Effluent dispersion, advection dispersal, partical tracking)	Water Quality	Extent of modelled area	Water Body
Magheraroarty, Co Donegal	1997	Limited	Both	Coastal erosion study	x	x			Magheraroarty Beach, Ballyness Bay	NW_170_0000
Lough Swilly		Limited	Both	Hydrodynamic study of Lough Swilly	x			x	Lough Swilly	NW_220_0000
Northern Ireland Coast		Limited	Both	Tidal flow study	x				Northern Ireland coastline	NWRBD, NBRBD
Inver Bay, Donegal Bay	2003	Y	Both	Impact assessment of sediment transport in Inver Bay	x		x	x	Inver Bay and Donegal Bay to the east of the given coordinates	NW_010_0000, NW_060_0000
Killybegs	1996, 2001	Y	Both	To examine the environmental impact of discharge from an outfall, particularly levels of ammonia	x		x	x	Killybegs Harbour out to Drumbanan Island	
Killybegs Harbour, Co Donegal	2001 - 2003	Limited	Both	Hydraulic modelling study	x			x	Killybegs Harbout, Co Donegal	NW_085_0000
Tory Island Harbour	1994 - 2000	Limited	Both	Modelling of wave disturbance and overtopping regimes	x				Tory Island Harbour	NW_180_0000
Buncrana Harbour	2000	Limited	Both	EIS for boat harbour	x			x	Buncrana, Co Donegal	NW_220_0400
Foyle Estuary	1998	Limited	Both	Development of water quality management strategy					Foyle Estuary	NW_250_0100
Flood Mapping for Northern Ireland	2003	Limited	Both	Flood Mapping for Northern Ireland					Northern Ireland including coastal areas	NBRBD, NERBD, NWRBD
Dogs Bay and Gurteen Beach Coastal Protextion	2004-5	Limited	Both	Coastal Protection Scheme	x	x			Northern Shore of Outer Galway Bay	WE_100_0000
Strandhill, Co Sligo	1999 - 2001	Limited	Both	Coastal regime study of active beach	x	x			Strandhill, Co Sligo	WE_450_0000
Caladh Mór/Cora Caladh, Inis Meáin	2003 - 2005	Limited	Both	EIS of proposed pier extension	x				Caladh Mór/Cora Caladh, Inis Meáin	WE_010_0000
POM (Princeton Ocean Model)	Subject to permanent advancement	Y	Both	Hydrodynamics of Galway Bay	x				Galway Bay	
Galway Bay ROMS		Restricted	Coastal	Physical climate, HAB prediction, single bay management	x		x	x	Galway Bay	WE_100_0000, WE_170_0000, WE_160_0000
Roundstone Marine	2004	Limited	Both	Hydrodynamic studies	x				Roundstone Marina	WE_230_0100
Inishbofin, Co Galway	2001	Limited	Both	EIS for proposed dredging scheme	x				Inishbofin, Co Galway	WE_250_0000
Killary Harbour ROMS		Restricted	Coastal	Physical climate, HAB prediction, single bay management	x		x	x	Killary Harbour	WE_310_0000
Clew bay ROMS		Restricted	Coastal	Physical climate, HAB prediction, single bay management	x		x	x	Clew Bay	WE_340_0000
Blacksod Bay, Co Mayo	2002	Limited	Both	EIS for pier extension and marina	x			x	Blacksod Bay	WE_360_0000
West of Ireland ROMS		Restricted	Coastal	Physical climate, HAB prediction, single bay management	x		x	x	West coast of Ireland to edge of continental shelf	WRBD, SHRBD, NWRBD
Atlantic Ireland SWAN		Restricted	Coastal	Wave climate for wave energy projects, sediment transport and tourism uses (surfing, yachting etc)	x		x		Shelf seas west of Ireland	WRBD, SHRBD, NWRBD
Skerd Rocks	2002	Y	Both	To predict the maximum wave height in the vicinity of Skerd Rocks	x				Skerd Rocks	WE_010_0000
Outer Galway Bay	2005	Y	Both	To examine flow from an outfall pipe in Spiddal	x		x	x	The entire bay to the east of the boundary defined by Fanore on south coast to Inveran on north coast	WE_100_0000
Inner Galway Bay	2005	Y	Both	To examine sediment transport in north Inner Galway Bay	x		x	x	Western boundary from Kilcolgan Port to White Strand	WE_170_0000
Rossaveel Harbour	2004 - 2005	Limited	Both	Dispersion studies	x				Rossaveel Harbour	WE_190_0000
Kilkieran Bay 2d	2004	Y	Both	Outfall study at Rossduggan Point	x		x	x	The entire bay to the east of the given coordinates	
Kilkieran and Greatmans Bay	2005	Y	Both	To examine water exchanges between Kilkieran and Greatmans Bays for possible bacteria transfer between fish farms	x		x	x	Both bays and their connections	WE_200_0000
Bertraghbui Bay (Bertraghboy Bay)	2005	Y	Both	To develop a 2d hydrodynamic model of Roundstone and Bertraghbui Bays	x		x	x	Roundstone and Bertraghbui Bays to the north and east of Mace Head to Gorteen Point	WE_230_0000
MIKE 21	2006		Coastal	Development of harbour and offshore facilities at Cleggan Co. Galway	x	x				
MIKE 22	2007		Coastal	Development of harbour and offshore facilities at Cleggan Co. Galway	x	x				WE_250_0000
Clifden	2003	Y	Both	To examine an outfall pipe near Clifden town	x		x	x	Clifden Bay	WE_270_0100
Killary Harbour		Y	Both	To produce an environmental impact assessment of the area with respect to increased aquacultural activities	x		x	x	Killary Harbour	WE_310_0000
Clew Bay and Approaches	2003	Y	Both	To develop a 3d hydrodynamic model of Clew Bay for various applications	x		x	x	The entire bay to the east of the given coordinates	
Clew Bay and Approaches	2006	Y	Both	To develop a 2d model of Clew Bay for comparison with 2003 3d version	x		x	x	The entire bay to the east of the given coordinates	
Clew Bay - Wave Climate Study	2005	Y	Both	To establish the wave heights at Bartraw Beach	x				The entire bay to the east of the boundary defined by the given coordinates	
Newport Bay	2004	Y	Both	To examine the environmental impact of discharge from an outfall	x		x	x	North Inner Clew Bay	
Inner Clew Bay 3d	2006	Y	Both	To examine the carrying capacity of Inner Clew Bay with regard to shellfish	x		x	x	The entire bay to the east of the given coordinates	WE_340_0000
Lough Furnace (1)	2004	Y	Both	Environmental assessment of discharge from an outfall on Lough Furnace and Newport	x		x	x	Lough Furnace and Newport Bay	WE_350_0300, WE_350_0200
Blacksod Bay	2004	Y	Both	To determine the assimilative and dispersion ability of the environment in relation to discharge from treatment works	x		x	x	The entire bay to the north of the given coordinates	WE_360_0000
Achill Sound	2003	Y	Both	Environmental impact assessments to determine the effects of a proposed turbot farm in Bunacurry	x		x	x		WE_370_0000
Broadhaven Bay	2004	Y	Both	To examine possible locations for a sewage outfal and its environmental effects	x		x	x	The entire bay to the south of the given coordinates	WE_400_0000
Crockets Town, Ballina, Co Mayo	2001 - 2004	Limited	Both	EIS for proposed sheltered moorings	x			x	Crockets Town, Ballina, Co Mayo	WE_420_0300
POM (Princeton Ocean Model)	Subject to permanent advancement	Y	Both	Tide surge model, hydrodynamics of irish waters	x				Irish coastal waters	
Irish Coastal Protection Strategy Study	2003 - 2005	Limited	Both	Review of Irish coastal protection requirements	x				Irish coastline	
Atlantic Ireland ROMS		Restricted	Coastal	Physical climate, sea bed classification, tidal prediction including direct astronomical forcing	x		x	x	All Ireland's territorial waters out to the Hatton Bank, south to Bay of Biscay, north to Iceland	Ireland

2.2 Conclusions

As noted above, a key conclusion of the Literature Review was that the most common approach to assessing and reporting the impact of morphological pressures involves a mixture of qualitative and quantitative assessments. This approach allows for the flexibility required to assess the site specific nature of TraC water bodies.

The lack of sufficient criteria and thresholds available to assess the risk of a water body failing to meet Good Status was evident. At the time of writing of the Literature Review it was concluded that this issue was being addressed by the UK-Ireland Marine Task Team. However, the progression of this work in relation to morphology, at the time of writing this final report, has yet to result in formal classification tools (criteria or thresholds).

3 DATA REVIEW

This section summarises the initial Data Review undertaken on commencement of this study (Appendix 3-1), outlines the final data findings and information collated. This section also details the method of data assessment and interpretation to assess morphological pressures and finally, makes recommendations for further data requirements

3.1 Introduction

An assessment tool was to be developed to allow systematic assessment of future marine morphological impacts on ecological status (/ potential). The tool should allow site specific assessment of proposals taking account of the existing quality status and pressures on the water body. The tool brings together all the work undertaken under the initial reviews within a structured decision-making framework based on analysis of risks and established pressure – impact relationships.

Due to issues of data ownership and the ownership of the developed tool (as detailed in this section), a finalised data store tool could not be developed and sourcing data for the assessments was hindered. However, despite these issues, a national coverage of marine pressures on the TraC morphology was created as shapefiles in a Geographic Information System (GIS) and provided together with an impact assessment tool, as identified in Chapter 2 and 5. These pressure shapefiles, with associated metadata, will be passed under data licence agreements to Cork County Council, the co-ordinating authority for the SWRBD at project completion. Many of these datasets were under constraints and restrictions in relation to assessment and dissemination. Therefore, all GIS outputs of this study will be passed to Cork County Council as the 'data holder'. A data catalogue of the incoming information was created to log data providers (who would be contacted in the event of any changes in the data or its status) and any licensing agreements or constraints. This information was also included in the metadata of each of the finalised layers, outlining the organisations from which permission should be obtained to change or use the data as required and from where updates may be generated. Data identified in Chapter 2 that was inaccessible was also recorded.

This information was collated and analysed using GIS in order to create pressure datasets. These areas and types of pressures were then used to carry out the impact assessment as outlined in Chapters 5 and 6. The following sections outline how these layers were created using the best available data to create a national coverage.

3.1.1 Metadata

Metadata is the structured recording of information about databases and GIS datasets. During the project, a detailed metadata catalogue was maintained of the incoming data including its sources, restrictions of use, owners, coverage, etc. This will be provided along with all the data to Cork County Council at the project close. Throughout the process care was taken to ensure that the data was licensed for use to the project, and able to be interpreted, processed as necessary and passed to Cork County Council.

Data was collected, collated and developed with reference to ‘Guidance on Information Management and Data Interchange between River Basin Management Systems and National Organisations’ reports (EPA, 2002).

In order to ensure the quality of the project and that results can be duplicated and any shortfalls recorded, detailed metadata of the final pressures was recorded within the shapefiles. The EPA issued a metadata style sheet of information required for each shape file. This pro forma includes information on the sources, restrictions, processes, organisations and individuals responsible for generating the data, as well as information on the extents and projection which is automatically calculated by ArcGIS. In addition, information fields required under the International Standards Organisation (ISO) 19115:2003 (and ISO/IEC 11179: 2004) were completed, in order to ensure all metadata that may be required for reporting to Europe or future reporting under the Infrastructure for Spatial Information in the European Community, EU Directive 2007/2/EC (INSPIRE) programme are included (INSPIRE, 2007). For each of the final pressure layers delivered with this project, full metadata has been recorded and stored as an xml file as outlined in the standards. In addition, the methods for the development of the pressure layers and source data are summarised below. Detailed methodologies will be passed to the SWRBD with the final morphological pressure layers.

3.1.2 Interim Data Review

The initial risk assessment undertaken as part of the Article 5 Characterisation identified gaps in the availability of quantitative information relating to the morphology of TraC waters. To address these gaps an interim Data Review was undertaken in 2005/2006 to:

- research both national and local datasets;
- include an assessment of the reliability of the data currently available;
- include studies currently underway or due to be commissioned during the life of this project, and
- summarise the data to be requested for inclusion in this Marine Morphology study

The interim Data Review is outlined in full in Appendix 3-1.

This interim Data Review outlined a proposal for the development of a Decision Support Tool, the data elements of which would act as a spatially referenced ‘data store’ tool. This ‘tool’ was intended to assist the end user in the regulation of coastal proposals with regard to the requirements of the WFD and morphology, i.e. determine whether morphological alterations could threaten the aim of achieving WFD objectives, or result in a deterioration of ecological status (for example from high to good status).

It was envisaged that compilation of this tool would involve the development of a database to hold all attribute data and information collected. This information would then be geo-referenced and displayed spatially using GIS software (ESRI ArcGIS).

It was initially proposed, and agreed with the Marine Morphology Steering Group, that the end users for such a tool should be the Marine Institute, EPA, the former DCMNR, or a combination of all three bodies, and as highlighted by the interim Data Review; confirmation of this ‘end user’ was fundamental to the licence agreements and data requests required for this study. However, notwithstanding support from the Marine Morphology Steering Group an appropriate end user for this tool was not identified. As a temporary alternative, to ensure the progress of this study, the SWRBD, and Cork County Council, were identified as substitute end users. The SWRBD, and Cork County Council, have no function to hold or use such a tool for the purpose of regulation and are intended only to temporarily act as the ‘end user’ until an appropriate assessment or regulatory body is identified. However, confirmation of an alternative end user has not transpired during the term of this study.

In the absence of an appropriate end user all formal data requests were issued via the SWRBD. Therefore, prior to the dissemination and/or editing of data resulting from this study permission must be sought from the data originators. To facilitate the future movement of data required for the assessment of morphology within TraC water bodies, it was proposed that only those datasets required for the further characterisation of pressures will be held by Cork County Council for dissemination to the ultimately identified end user. Therefore, a data store tool containing details of morphology and biology as well as that for pressures was not generated for temporary hosting by the SWRBD as it is considered that the future end user of this tool will inevitably hold more detailed data to that available to this study. Also, compliance with licence agreements for many datasets will require this data to be requested [and edited where necessary] again under the new terms for the ultimate end user. This report, therefore, recommends the structure of an appropriate Decision Support

Tool and summarises the data identified as useful to both the assessment and regulation of coastal development/activities using such a tool.

The data regenerated by this project for the pressures identified will be passed to Cork County Council together with methods of generation and metadata. This data can be uploaded into the EPA National WFD 'schema' by Cork County Council, as appropriate. The EPA National WFD schema is a national database of WFD data to which data can be uploaded by relevant authorities to ensure all regulatory parties involved in national and local government have access to the same data, and that this is as up to date as possible. The pressures data has been created in a format compatible with this database.

This uncertainty caused significant delays in data acquisition, and prevented access to several key datasets identified in the interim data review. Data such as the ongoing work on coastal flood management zones (GIS, mapping and LiDAR (Light Detection and Ranging)), Ordnance Survey (OS) maps, the Skipper series hydrographic charts and a number of other national resources were unable to be accessed by this study, despite numerous attempts. The purchasing of additional licences was not possible.

As much of the work in updating the existing information structures within the former DCMNR was underway at the time of dissolution, many of the sources of information that were to eventually be made available electronically are only available in paper form. Despite a concerted research effort on behalf of this project, not all of this information could be accessed or summarised. For example, the Coastal Engineering Division of the former DCMNR has a drawing archive of coastal structures, bridges etc. Whilst the project was eventually granted permission to access this extensive, restricted in-situ archive, the nature of the resource meant it was not practical for assessment for a national study. Where possible, these data sources have been identified in the interim data review and in following sections so that specific studies or future development appraisals can identify these resources.

The sources used to assess the morphological pressures on water bodies in Ireland are outlined in this chapter. Information on source datasets has been provided for each of the pressure types together with background information. The data collated, full data catalogue and derived information will be provided to Cork County Council at the project end where it will remain until such time as a suitable data owner can be identified.

3.1.3 Tool Development

The tool structure developed is divided into two components as noted previously:

1. **Data Store GIS**: this holds and displays the collated data to assist regulators in decision-making. The functionality of this tool can be summarised as follows:
   - The user will assess the information provided by an applicant for a proposed development/activity e.g. foreshore licence or dumping at sea application. It is envisaged that future applications will be accompanied by digital information that can be used to update the data store.
   - The user can then view and query the data relating to existing pressures within GIS. Future development of this tool will benefit greatly from WFD monitoring results.
2. **Morphological Impact Assessment**: The data store GIS provides baseline data which a regulator can interpret using expert judgement to make a decision. This second function however, uses generic assessments of potential changes to the morphological features attributed to each water body type to estimate the risks to ecology. The future development of this function will also benefit from WFD monitoring results as well as the outputs of research projects such as INFOMAR (the Integrated Mapping For the Sustainable Development of Ireland's MARine Resource); a joint venture between the Geological Survey of Ireland (GSI) and the Marine Institute.

The combination of the above elements will inform the further characterisation of TraC waters and provide a suitable approach to assist coastal managers and regulators in assessing the potential impact of future developments on individual water bodies.

Following the identification of relevant datasets and key organisations within the interim Data Review, data requests were issued to all RBD, relevant public institutions, academia and various consultancies. The main categories of information requested for this study were ***Pressures*** (anthropogenic activities), ***State*** (morphological conditions), and ***Receptors*** (WFD biological quality elements: phytoplankton, macroalgae, benthic invertebrates and fish (transitional only)).

Sections 3.2 and 3.3 below outline the data reviewed, requested, collated and edited as part of the Marine Morphology study. In summarising this data, Section 3.4 confirms the identified data gaps associated with the assessment and regulation of morphological alterations and outlines the key recommendations for further data requirements to fully develop an appropriate Decision Support Tool.

3.2 Final Data Review Findings

One conclusion from the interim Data Review can be carried forward to the findings of this final Data Review – that is that the existence and availability of information in suitable formats relating to the pressures on, and the attributes of, morphology in Irish TraC waters is very limited. For example, many resources relating to coastal structures exist in non-spatial or paper format, such as foreshore licence records and plans of infrastructure extents. On meeting with the former DCMNR to discuss such issues, the Marine Morphology study was informed of a national project which planned to digitise such information held by the department creating a GIS based data store. However, on the transfer of the former DCMNRs' functions following the General Elections in 2007 it is unclear how this is being progressed. Through continued communications with the bodies involved it appears that the situation is still to be resolved at the time of writing.

A significant restriction to data acquisition for this study centred on the uncertainty expressed by data originators relating to the final use of the data requested. The identification of the SWRBD (Cork County Council) as end user assisted this process; however, difficulties were experienced throughout the study. This data acquisition process was further hampered and delayed by the dissolution of the DCMNR, which lead to uncertainty of data ownership of government marine data, and an inability of former marine departments to release the information until the issue was resolved. A number of marine data and GIS programmes, were stalled or ceased altogether. Several of these data consolidation projects were initiated to assist the implementation of the WFD, its daughter directives and 'Sea Change' programmes. The urgent need for a responsible body, preferably a governmental department, agency or agent to take ownership of this process was reiterated by the Steering Group.

In order to ensure consistency, all data was assessed in Irish National Grid (TM65) projection as defined by the water body boundaries and this information was included in the metadata. For some datasets small spatial shifts in the conversions were noted and in general could be corrected by the ArcGIS projection tools. However, some data with WGS84 projections noted a marked and consistent shift. This was eventually tracked to a small error in the automatic re-projection calculation. The error was reported to ESRI who were able to correct the problem. All datasets created were subject to spatial and attribute quality assessments and the information included in the metadata.

3.2.1 Baseline Data

Data resources for baseline data are listed in Table 3.1, the following section outlines the data resources and sources and problems encountered. The baseline data provides much of the background information for the assessment, in addition, it provides the information used for visual interpretation of water bodies and pressures.

3.2.1.1 TraC Water Body Boundaries

The TraC water body boundaries used throughout the Marine Morphology Study were sourced from the EPA via the SWRBD. Water body boundaries were created using OSi 1:50,000 vector data (High Water Mark (HWM) and Low Water Mark (LWM)) and national territory from the 1959 Maritime Jurisdiction Act. The full metadata for these datasets is available from the EPA (www.epa.ie/metadata). Some digitising errors were identified by this study; these consisted of very small overlaps and also the splitting of Erne Estuary into two areas along the North West coast (see Figure 3.1 below).

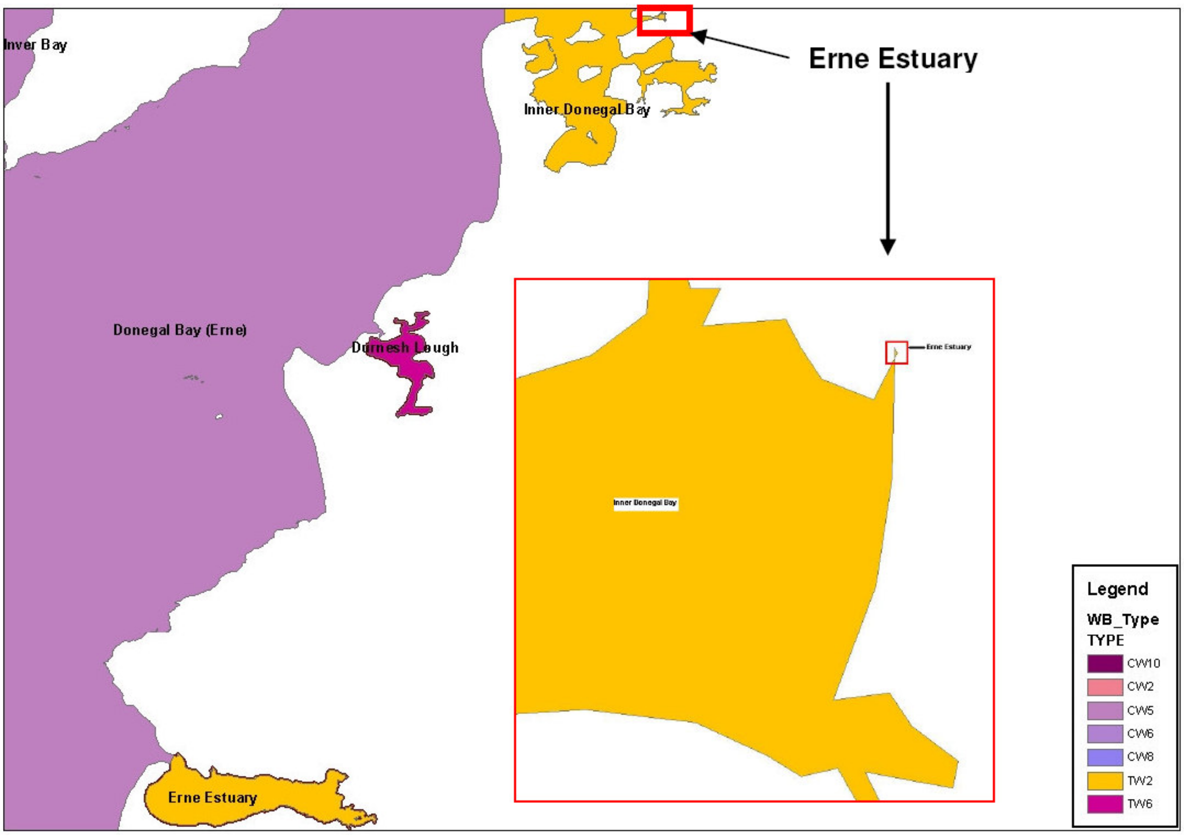


Figure 3.1: Digitising error associated with Erne Estuary

3.2.1.2 Irish Coastline / High Water Mark

The dataset referred to as Ireland's coastline for this study is that provided by the SWRBD which was sourced from the EPA. The coastline polygon was defined by the HWM from the 1:50,000 OSi mapping which was also provided by the SWRBD (See Table 3.1). The full metadata for the HWM is available from the EPA. On review of these datasets, slight discrepancies were identified between the coastline polygon and the HWM it was created from, an example of which is illustrated in Figure 3.2 below.

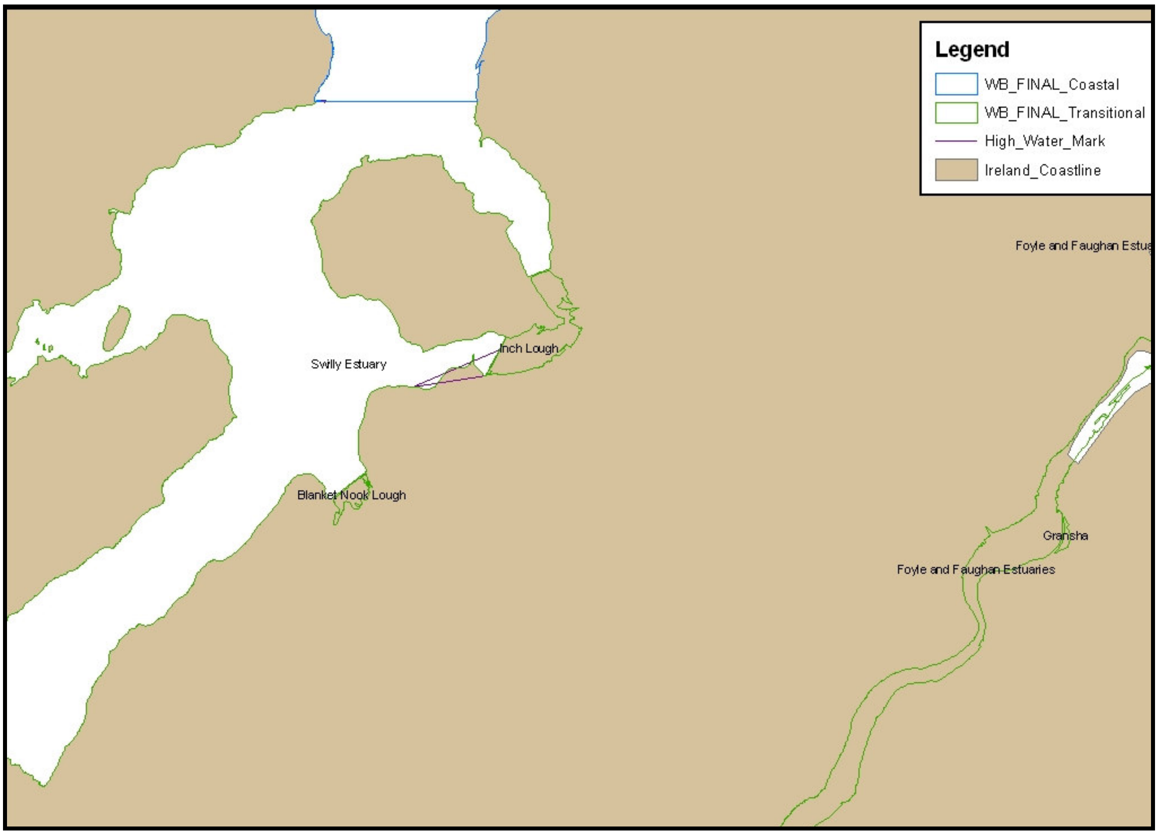


Figure 3.2: Example of discrepancies found between the Irish coastline polygon and HWM in the Swilly and Foyle Estuaries.

Figure 3.2 indicates areas where the coastline polygon (brown) excludes whole water bodies (Inch Lough and Blanket Nook Lough). Also a digitising error in the HWM polyline layer is visible between Swilly Estuary and Inch Lough. To help overcome these discrepancies prior to further data analysis a substitute coastline polygon file was created using the landward boundaries of the TraC water bodies (as sourced from the EPA). This aimed to minimise errors and ensure the total area of TraC water bodies recorded by the EPA was carried forward throughout the study.

3.2.1.3 Intertidal Area

To facilitate an assessment of pressures within Ireland's TraC water bodies, the proportion of these pressures occurring within the intertidal zone was required to be calculated. The intertidal area (or foreshore), can be defined as the area exposed to the air at low tide and submerged at high tide. In the absence of a national delineated intertidal zone, this zone was estimated as part of this study using datasets representing Ireland's high and low water marks.

The EPA provided the Marine Morphology Study with a national LWM layer sourced from the OSi at a scale of 1:250,000. This is not a very accurate scale to represent LWMs. However, the national OSi LWM at a scale of 1:10,000 (1:50,000 for islands) was unavailable to this study due to licensing restrictions. To supplement the 1:250,000 LWM the SWRBD provided 1:50,000 vector maps for Cork and Kerry. Further into the Marine Morphology study, vector maps were provided for counties Donegal and Louth. However, these were not incorporated into the Intertidal zone which had already been generated.

To estimate the intertidal zone of the TraC waters the area of water body between the HWM and LWM was calculated using the 1:50,000 LWM for Cork and Kerry and the 1:250,000 data for all other coastal areas. As noted above, the coastline (HWM) layer contained some discrepancies and for the purpose of this calculation the substitute coastline polygon created from the inner boundaries of the TraC water bodies was used as the HWM. Figure 3.3 below illustrates the intertidal and subtidal zones estimated for Castlemaine Harbour and Cromane transitional water bodies in the SWRBD.

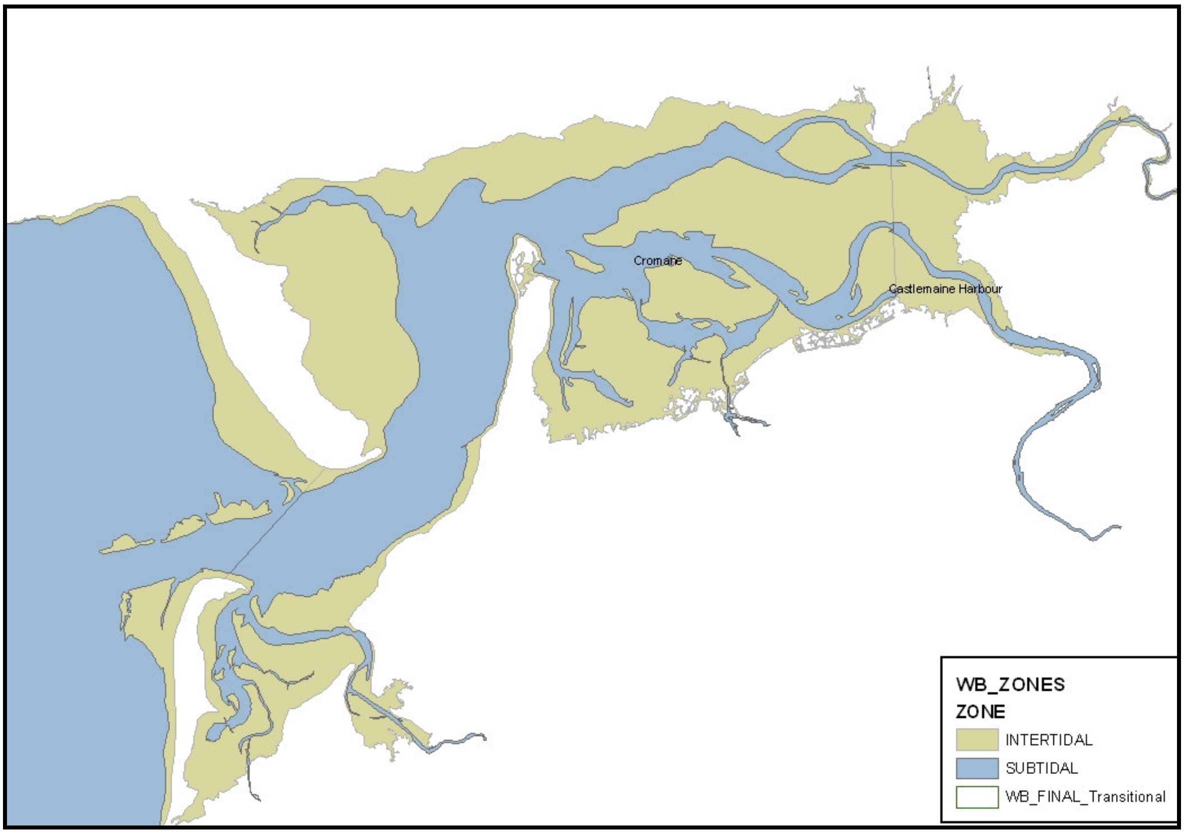


Figure 3.3: Intertidal and subtidal zones estimated for Castlemaine Harbour and Cromane

3.2.1.4 CORINE

The Coordination of Information on the Environment (CORINE) Land Cover 2000 database was made available to this study by the EPA via the SWRBD. This dataset proved useful both in the identification of areas of potential ILU and as a tool to focus the identification of pressure types. For example, the urban, transport and industrial land cover areas identified by CORINE were used to help focus the identification of areas of reclamation, flow and sediment manipulation structures (structures lying perpendicular to the coastline) and causeways.

3.2.1.5 Foreshore Licence/Lease Register

Following the initial risk assessments, licensing information such as that associated with foreshore licences and leases was identified as a useful source of data to help further characterise the pressures on the morphology of Ireland's TraC waters. It was envisaged that a review of the former DCMNR's register of foreshore licences and leases would highlight those records of potential relevance, after which the associated licence documents, which are held in paper format in the former DCMNR's Coastal Division offices, would then be reviewed in detail. However, following a successful meeting with the former DCMNR and the Marine Institute, the former DCMNR Coastal Zone Management Division relocated from Dublin to Clonakility, Cork at which time all files were unavailable to external bodies. Following this relocation, the transfer of responsibilities of the former DCMNR under the Foreshore Acts had yet to be confirmed, further restricting access to these documents.

To progress with the information available to the Marine Morphology study; a spreadsheet listing deeds relating to foreshore licences and leases issued under the Foreshore Acts (1933 – 1998) for the years 1933 – 2005 and prior legislation was downloaded from the former DCMNR website. This information was then converted to an ESRI compatible shapefile which was then used to help focus the review of existing data and orthophotos for additional pressures.

Each record within the register was assigned a pressure 'type' based on the descriptive information supplied in the register, and following a map search those records associated with pressures types relevant to this study were assigned a water body code. This register did not provide very detailed location information for the activities/developments, and water body codes were only assigned to 1236 of the 1984 records.

No coordinates were provided with the register therefore to display these records in ArcMap they were attributed to centroids of the water bodies and a new shapefile displaying these licence records as points was created. It should be noted that details of the extent of pressures e.g. area dredged are not provided with the foreshore register.

3.2.1.6 Environmental Impact Statement Register

As part of the Literature Review, Environmental Impact Statements (EIS) identified as relevant to the pressure types assessed by this study where obtained from ENFO, Ireland's public information service on environmental matters (see Appendix 3-2). As with the foreshore licence/lease records pressure 'types' and water body codes were assigned to each EIS record. These records were then attributed to centroids of the water bodies to create a shapefile displaying the EISs as points in ArcMap. A dataset of relevant marine EIS areas was provided by the Marine Institute as ArcGIS polygons.

3.2.1.7 Coastal Images

Georeferenced images of Ireland's coast were required to facilitate the assessment and, where necessary, digitising of pressure extents (footprints).

National infra-red coastal images sourced from the National Coastline Survey of Ireland (Marine Institute / Compass Informatics / Enterprise Ireland, 1998 - 2002) were received from the Marine Institute. However, these images, with the exception of Dunmanus and Bantry Bays, are not georeferenced and require the use of the project's map viewer to interrogate the images. The Marine Institute plan to georeference all images, which on completion will provide an invaluable resource to the outputs of this study.

Orthophotos were requested from each RBD via the SWRBD, and over 30,000 orthophotos where received (inland and coastal coverage). Using numeric grids provided by the OSi via the SWRBD, those images required for assessment were identified and retrieved from this large database of images.

Not all images received were georeferenced, and overall coverage varied across the coast with counties Kerry, Cork, Waterford and Dublin having substantial coverage (see Table 3.1). No orthophotos were received from the South Eastern RBD (SERBD), and although some coastal locations were covered by images provided by the Eastern and South Western RBDs, the majority of the coastline remained uncovered.
Figures 3.4 - 3.9(b) below illustrate the coverage of orthophotos made available to this study for each RBD.

North West RBD

Orthophotos received for the NWRBD were in a MapInfo format. There is extensive orthophoto coverage of the NWRBD coastline with only a few gaps as shown in Figure 3.4

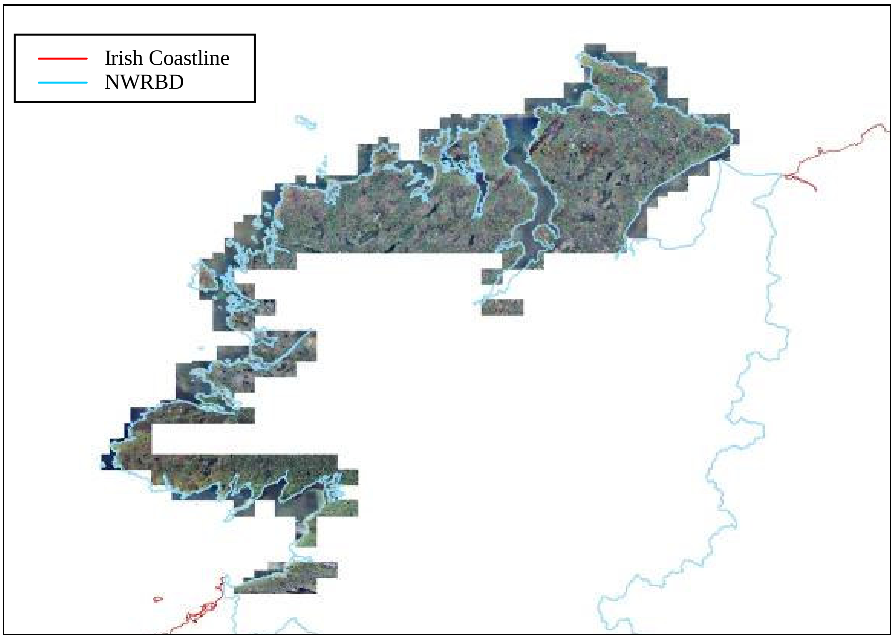


Figure 3.4 - MapInfo orthophoto coverage of the NWRBD coastline.

Western RBD

Aerial images were received for the majority of the WRBD coastline (Figure 3.5), however only approximately 40% are geo-referenced.

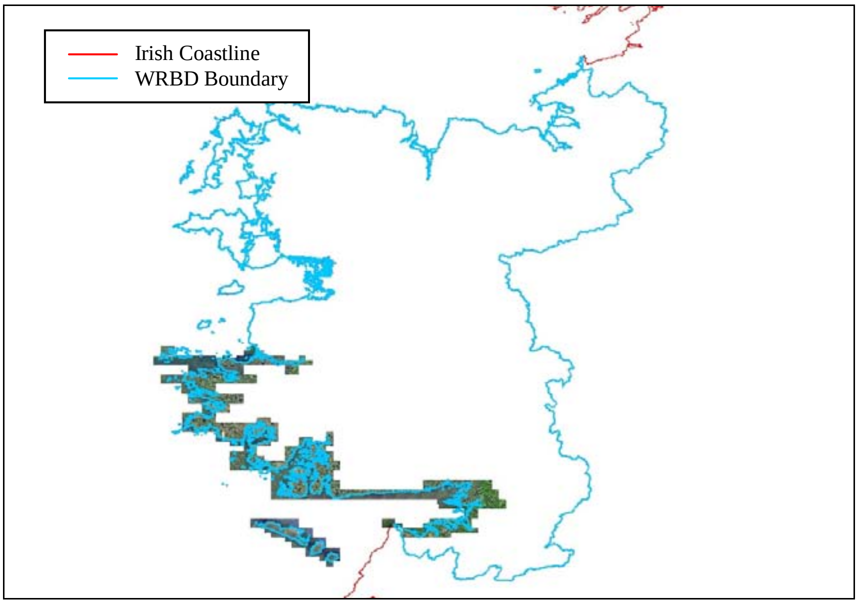


Figure 3.5 - ArcMap orthophoto coverage of WRBD coastline.

Shannon RBD

Figure 3.6 shows the coverage of orthophotos received for the Shannon RBD coastline. Orthophotos were received for approximately 50% of the coastline. Additional aerial images were received in the Limerick City region but lacked spatial references.

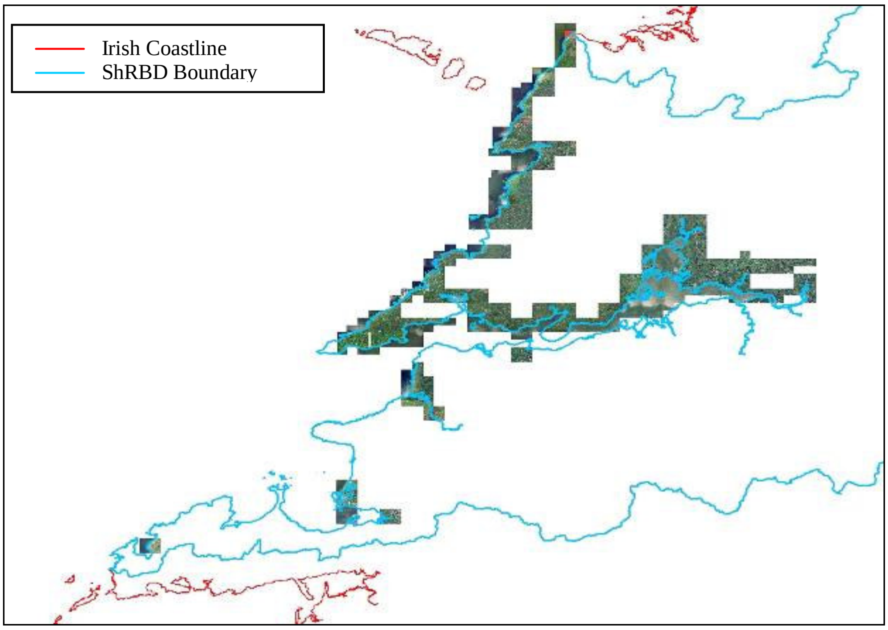


Figure 3.6 - ArcMap orthophoto coverage of the Shannon RBD's coastline.

South West RBD

Figure 3.7 shows the orthophotos made available to this project for the SWRBD coastline. County Cork is covered by a single mosaic file. County Kerry orthophotos were individual, but georeferenced. County Waterford images were contained within SERBD mosaic (see Figure 3.8).

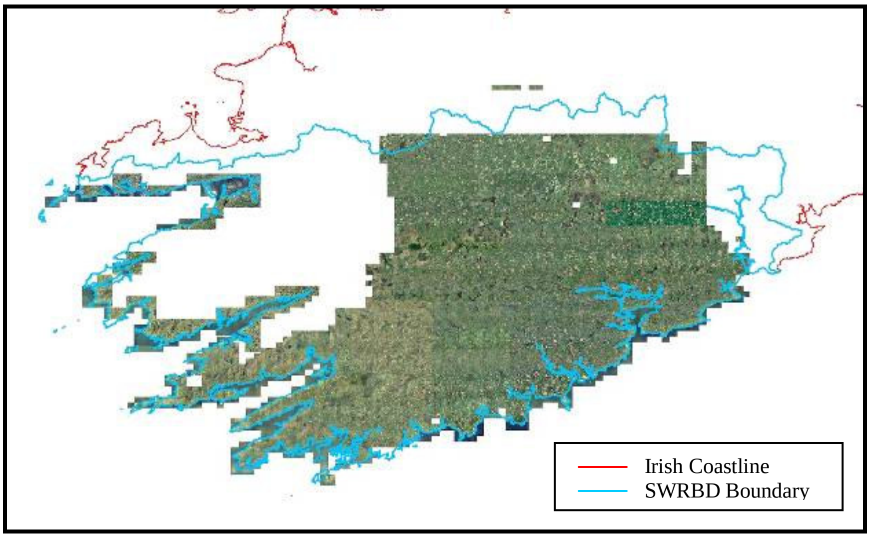


Figure 3.7 - ArcMap orthophoto coverage of the SWRBD coastline.

South East RBD

There was minimal orthophoto coverage of the SERBD coastline as shown in Figure 3.8

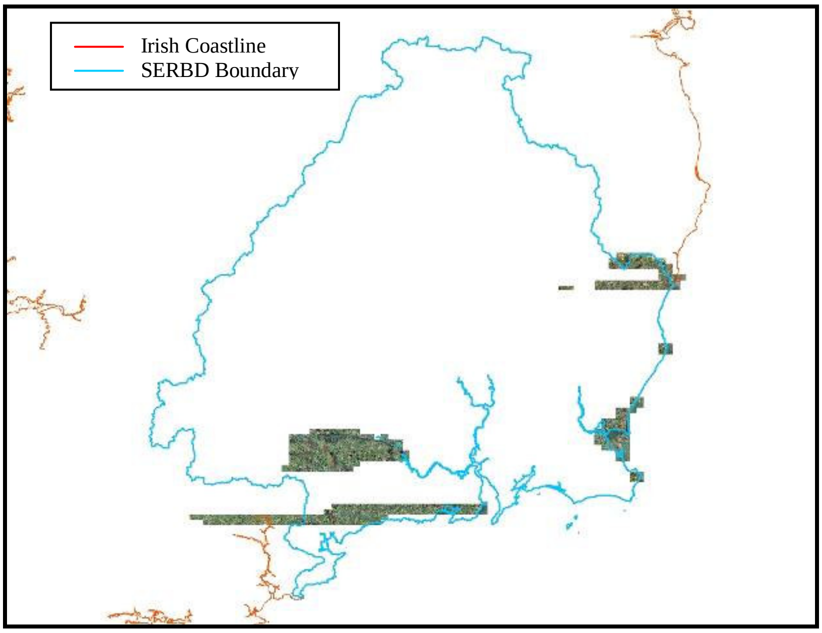


Figure 3.8 - ArcMap orthophoto coverage of the SERBD coastline.

Eastern RBD

Figure 3.9(a) and 3.9(b) convey of the orthophotos made available for the ERBD, Note that there are two figures to show the overlapping mosaic files

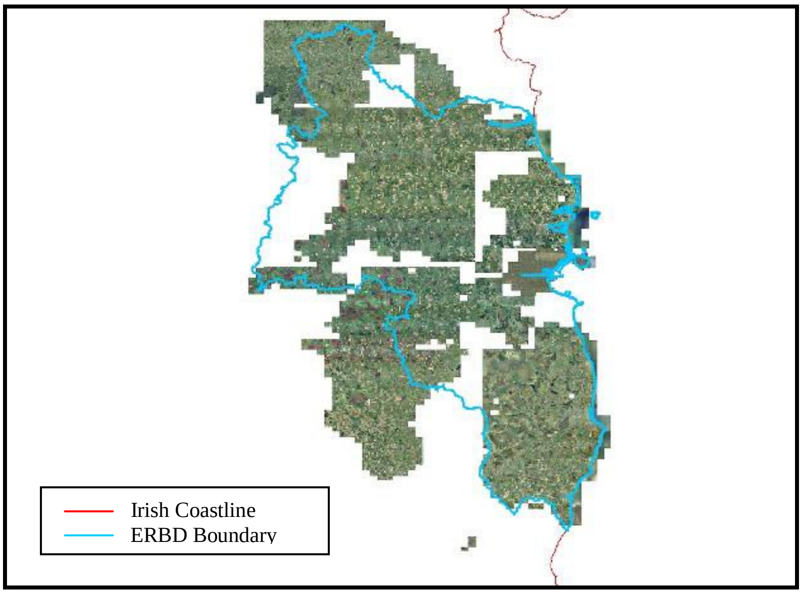


Figure 3.9(a) - ArcMap orthophoto coverage of the ERBD coastline.

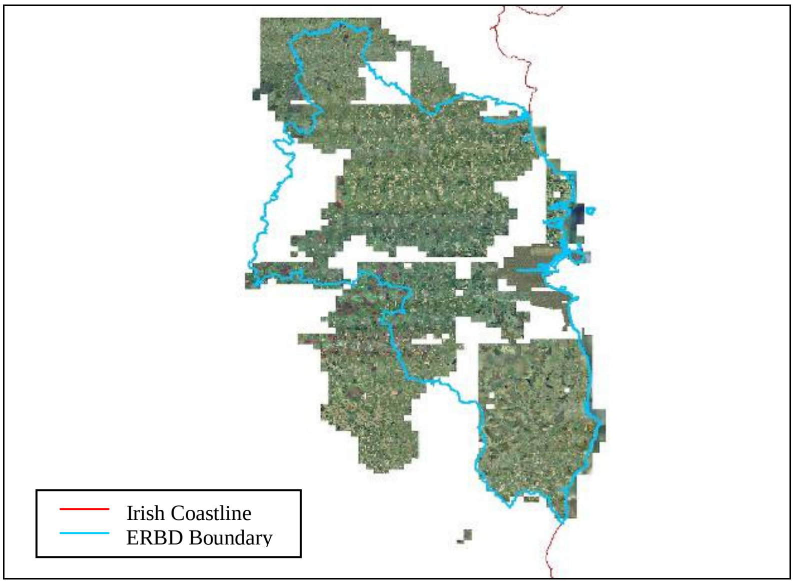


Figure 3.9(b) - ArcMap orthophoto coverage of the ERBD coastline.

In addition to the poor coverage of orthophotos for some areas, the resolution of these images varied greatly, an example of which is shown in Figures 3.10 and 3.11 below.

Figure 3.10: Low resolution image of Dublin

Figure 3.11: High resolution image of Dublin

Coastal images were used to help clarify the type of coastal structures as well as digitising structure extents. Therefore, for areas of poor resolution it was difficult to visualise the exact extents of structures being digitised due to its coarseness.

The EPA's online Envision mapper proved a useful tool to help clarify some pressures identified in areas where only low resolution orthophotos were available.

Oblique images produced by the former DCMNR Coastal Helicopter Survey (SnapMap Project) were made available for review for this study. On receipt, all photographic images were copyright 2004 DCMNR. These images proved very useful to the identification and assessment of all the pressures types.

3.2.1.8 Historic Maps

Historical maps of Ireland were requested for use by the Marine Morphology study to assist with the identification and assessment of coastal reclamation. Focusing on urban and industrial areas and where foreshore licences/leases and EISs indicate reclamation, available orthophotos were overlaid with historic maps to search for coastal land alterations.

Cork County Council provided a mosaic of georeferenced historic maps for Cork and part of Kerry generated from 6" maps (early 1900's) for use by this study. All local authorities hold historical maps for their particular area. However, for the most part these maps were not available georeferenced for use by this study.

National georeferenced historic maps are available for Ireland from the OSi, and can be viewed at OSi's online Historical Mapping Archive (http://www.irishhistoricmaps.ie/historic/) for a daily, weekly, monthly or yearly fee. These maps however, are only available for download in PDF (Portable Document Format).

An alternative source of historic maps was identified as georeferenced bedrock maps available from the GSI. These are 6" to one mile maps dated between 1860 and 1910. More than 2500 historic maps were obtained for assessment of Ireland's coast. These maps were georeferenced to 1:750,000 scale and were used by permission of the GSI. As with the orthophotos, numeric grids were used to identify and retrieve the images from the large database received. This dataset was comprehensive, though there were some localised areas with incomplete coverage, where specific tiles were not available. Unlike the orthophotos the coverage was nearly national. However, in order to carry out the assessments, both ortho-photographs and historic maps were required, as detailed below.

3.2.1.9 Bathymetric Data

Limited bathymetric information was available to this project. After extensive review and identification of possible resources, it was established that this is due to the limited availability of bathymetric data for Ireland. Hydrographic Charts have been electronically digitised on a world wide basis in recent years. Raster charts (georeferenced pictures) for Ireland are available, and are were licensed to the former DCMNR. However, with the re-affiliation of governmental department responsibilities, the ownership of this licence remained in question for much of the project and was ultimately unavailable. The vectorised charts were being prepared by organisations such as SeaZone (a commercial subsidiary of the UK Hydrographic Office) which had prepared draft GIS data for areas of Irelands waters in 2006 and were used under licence by the former DCMNR for projects such as the Irish Offshore Strategic Environmental Assessment (SEA) (Petroleum Affairs Division (PAD), 2006). Neither of these organisations was able to provide even draft copies of this information due to ongoing licence negotiation with Ireland.

The bathymetry used for the initial typology was of insufficient coverage and resolution for further analysis. Based on the 1997 GEBCO (General Bathymetric Chart of the Oceans) bathymetry, this dataset does not cover the inshore areas. Localised information was available from a number of studies such as the NPWS surveys of Special Areas of Conservation (SACs) and some of the marine models but this was inconsistent on a national basis. Chapter 4 identifies the future survey programmes designed to provide this information. The results of these programmes may influence the future characterisation

Table 3.1: Data Resources – Baseline information used in the assessments.

The following table lists the baseline resources used in the assessment and digitising of the TraC-MImAS pressures. The information includes the data source (received from) and the data owner or developer.

File Name/Type	Data Description	Geographic location	Sourced from	Data Owner / Originator
15374 2219_WFDGDB (CD 1 of 2)	Water bodies and national Article 5 Risk Assessment Datasets (excludes morphology datasets)	RoI	SWRBD	EPA
Orthophoto mosaic	Mosaic of Cork and some of Kerry aerial photos	Cork & part of Kerry	SWRBD	Cork County Council/Osi
15374 2231_Cork-Kerry-Waterford photos and vector	Orthophotos for Cork, Kerry and Waterford	Cork, Kerry and Waterford	SWRBD	OSi
15374 2258_Orthophotos and vector maps for Cavan, Longford, Monaghan and Donegal	Orthophotos and vector maps for Cavan, Longford, Monaghan and Donegal	Cavan, Longford, Monaghan and Donegal	EPA	OSi
15374 2261_Orthophotos for Shannon	Orthophotos for Shannon (12 Disks)	ShRBD	SWRBD	OSi
15374 2262_WRBD and ShRBD GIS Data and Photos	Orthophotos for WRBD	WRBD	SWRBD	WRBD/ShRBD/OSi
15374 2263_ERBD GIS Data	Orthophotos for ERBD	ERBD	SWRBD	OSi
15374_2238_CoastView	Georeferenced infra-red images of Bantry Bay and Dunmanus Bay	Bantry Bay and Dunmanus Bay	MI	MI
15374 2260_GSI - Historic Map Index	Historical 6 inch map Index of Ireland	RoI	GSI	GSI
15734 2264_GSI_Irish_Coastal_6inch_Historical maps	Historical 6 Inch maps for the Irish Coastline	RoI	GSI	GSI
15374_2236_IrishCoastalSurvey22-12-04_V3	SnapMap, oblique images of the coast of Ireland - Second collection from DCMNR (corrected image references).	RoI	DCMNR	DCENR
Environmental Impact Statements	Copies of EIS documents and catalogue summarising relevant details within the EISs, such as ecology, mitigation measures used.	RoI	ENFO	N/A
EISDevelopmentMapping.shp	EIS Development Mapping	RoI	MI	MI

Table 3.1(continued): Data Resources – Baseline information used in the assessments.

File Name/Type	Data Description	Geographic location	Sourced from	Data Owner / Originator
15374 2268_Foreshore Lic Download	Foreshore register downloaded from the former DCMNR website 09/10/2007	RoI	DCMNR	DCENR
High_Water_Mark	HWM defined by 1:50,000 OSi mapping	Ireland	SWRBD	EPA/OSi
Ireland_Coastline	Ireland polygon; coastline defined by 1:50,000 OSi mapping (HWM)	Ireland	SWRBD	EPA/OSi
15374 2256_National LWM_EPA	LWM and HWM OSi 1:250000	Ireland	EPA	Osi
Vector	Cork & Kerry vector maps (towns scaled to 1000, 2500 and 5000; coastline scaled to 50000)	Ireland	SWRBD	Cork County Council/Osi
clc00_ie	RoI land cover types defined to level 3 detail	RoI	SWRBD	EPA
clc00_lev6	RoI land cover types defined to level 6 detail	RoI	SWRBD	EPA

3.2.2 Pressures

The pressures assessed within this study are discussed in detail in Chapter 5 in relation to their potential impact on the morphology of TraC waters. The purpose of this section is to outline the information considered for the further characterisation of each pressure type and how this was prepared for assessment using TraC-MImAS. The TraC-MImAS tool was developed to help regulators determine whether changes to the morphology of TraC waters could pose a risk to ecology, and thereby identify those that could threaten the aim of achieving GES or result in a deterioration of ecological status (see Chapter 2 and 5). The tool uses a concept of 'system capacity' (allowable morphological change) to measure impacts to morphological conditions. The tool assuming that a pristine water body has a measure of assimilative 'capacity', which is degraded by anthropogenic activities or pressures.

TraC-MImAS requires each pressure to be defined by its 'footprint' (area/length) per water body as well as its proportion per tidal zone, i.e. intertidal and subtidal zone to assess the pressure areas against the 'system capacity'.

As part of the initial risk assessments undertaken in Ireland, preliminary information on the those pressures outlined in Section 2 above was obtained and translated into files compatible with the ESRI GIS 'ArcGIS'. Shapefiles were created for each of the pressures identified e.g. polygons of areas dredged. On completion of the initial risk assessments, each RBD submitted the shapefiles collated for their District to the EPA who then merged these to create national shapefiles for the purpose of reporting to the EC.

The baseline datasets outlined in Section 3.2.1 above are common to the assessment of most if not all the pressures. The coverage of orthophotos and historical maps, for the purpose of land claim pressures, was fundamental to the identification of pressure extents. In the absence of orthophotos, the EPA Envision online mapper could be used to clarify some pressure extents. However, pressures were only digitised in those areas where orthophotos were available (as shown in Figures 3.4-3.9(b) (orthophotographic coverage noted under Baseline section)).

3.2.2.1 Dredging, Other Disturbances & Disposal at Sea

'Dredging' and 'Disposal at Sea' are two pressures identified by the initial risk assessments as potentially impacting on the morphology of TraC water bodies. For the purpose of further characterisation Dredging is defined as either 'Dredging - High Impact'', which corresponds for the most part to capital dredging (first time, deep dredge), or ‘Dredging - Low Impact’, which corresponds for the most part to maintenance dredging (navigational channels etc).

The pressure ‘Other Disturbances to Seabed’ is defined as “any other temporary disturbances to bed morphology or substrate character where the impacts are likely to be restricted to the area of bed directly disturbed and where the bed is likely to recover significantly over time” (see Table 3.2). Shellfish dredging, vessel movements, wind farms, cables and pipelines were considered to represent this pressure type.
Wind farm zones were included in this pressure as, although the sea bed is unlikely to recover “significantly over time” following development of these farms; these areas are currently only ‘zoned’ and therefore likely to be subject to investigative surveys. For the most part, these zones are offshore and outside the boundaries of the WFD water bodies.

As noted in Section 2.1 of this report, aquaculture is outside the scope of this study. However, as this is such a prominent activity in Irish TraC waters, and is not being considered elsewhere, it was agreed with the Marine Morphology Steering Group that the pressure ‘Other Disturbances to Seabed’ should represent the aquaculture activities of shellfish dredging and trawling only. This is a similar approach to that of the NS-Share Marine Morphology study for which aquaculture was assessed and therefore assists in harmonisation throughout Ireland. No detailed assessment was undertaken for aquaculture other than the mapping of worked and licensed areas.

Data Resources

The following section outlines the data resources identified by the source organisations.

Office of Public Works

The information used to further characterise maintenance dredging included that associated with arterial drainage schemes and drainage districts as recorded by the Office of Public Works (OPW). The OPW is the Irish Government’s principal engineering agency whose work includes the maintenance of arterial drainage schemes and the development, design and implementation of urban flood alleviation works. For the purpose of the initial risk assessments, the OPW released this information to the RBDs in 2004 for use in WFD assessments. However, in January 2005 the OPW released updated datasets for arterial drainage schemes and drainage districts to replace that previously issued. This first revision includes corrections made to the channels, benefiting lands and embankment records only. Corrected GIS layers for Drainage Districts, Bridges, Sluices and Weirs have yet to be released.

Marine Institute

The Marine Institute provided shipping navigation channel data, which in the absence of accurate maintenance dredging information, was used to provide the area impact of the navigation channels. These areas must be maintained for safe navigation and therefore are subject to maintenance dredging as required. Records from the former DCMNR foreshore and dumping at sea databases and the series of excel spreadsheets that were compiled by the Marine Institute were used to ensure the areas were subject to maintenance dredging. (Table 3.2) These sources also provided information and locations of dumping at sea areas. Attribute information on the nature of the dredge / dump material, Site IDs and Licence numbers were added to the dumping at sea areas.

The Marine Institute also provided information on subsea cables from the Kingfisher cable safety charts as part of information used to assess areas designated for future offshore wind farm development. These areas were also assessed as other disturbances to seabed, as some are already being developed.

Fisheries information was provided by the Marine Institute, providing information on inshore fisheries and fishing gear usage.

Former Department of Communications, Marine and Natural Resources

The former DCMNR provided a number of datasets on foreshore and licensing information via their website, the Marine Licence Vetting Committee and the Marine Institute. The former department had begun programmes to collate this information under the Costal Zone Administration System (COZAS) programme, but due to departmental reorganisation these programmes had been stalled indefinitely. As a result the positional accuracy of the received data was insufficient to estimate the extents in most cases.

As an interim measure, the former DCMNR allowed access to their licence for oil and gas infrastructure from Oilfields Publications Ltd.

Similarly the Integrated Fisheries Information System (IFIS), which was intended to provide information on aquaculture and inshore fisheries, is currently unavailable. As a result, information from existing databases was combined and compared; most notably the 2005 Aquaculture database the forerunner to the IFIS, which was provided by the former DCMNR and DAFF.

Bord Iascaigh Mhara (BIM)

BIM provided shellfisheries area data for some of the RBD areas. Much of the data BIM had available was incorporated into the aquaculture database provided by the former DCMNR. However, information on bivalves fisheries could be assessed, though there was incomplete national coverage for this dataset.

Reference Information

Ferry route information was used from the ArcGIS European information. This is a series of sets of information provided by the US National Imagery and Mapping Agency (NIMA) and is based on USGS (United States Geological Survey) and the CIA (Central Intelligence Agency) world gazetteer data. The dataset includes coastline data (1:1,000,000), towns, cities, major rail and road links. The ferry routes are given for major European and UK routes.

Table 3.2: Data Resources: Summary of the information assessed for the purpose of further characterising Dredging, Disposal at Sea and Other Disturbances of Seabed

This table outlines the data used to assess seabed disturbances, including dredging and dumping at sea. In addition, where available, reports, licences and other information were consulted to provide verification or further information on activities.

File Name/Type	Data Description	Geographic location	Pressure	Sourced from	Data Owner / Originator
morphology_polygons_national.shp	National shapefile for both dredging and dumping at sea. Combination of records submitted by RBDs. Attribute data limited to Marine Dredge Area' or Marine Dumping'	RoI	Dredging / Disposal at Sea	EPA	DCENR
RBD identified Dredge locations (shapefile)	Collated from DCMNR dredging locations specified by dumping at sea applications	SWRBD, SERBD, ShRBD	Dredging	RBDs	DCENR
RBD identified Dredge locations (MS Excel spreadsheet)	Collated from DCMNR dredging locations specified by dumping at sea applications	SWRBD	Dredging	SWRBD	DCENR
Drainage Schemes & Drainage Districts	National Drainage Schemes (maintained by OPW) & Drainage Districts (maintained by Local Authorities)	RoI	Dredging	SWRBD	OPW
ShippingNavigationChannels.shp	Shipping Navigation Channels. Navigation channels must be maintained for safe navigation, therefore the channel areas represented by this dataset was used as the basis for the maintenance dredge area. This dataset does not contain detailed attribute data.	RoI	Dredging	MI	MI
RBD identified Aquaculture areas (shapefile)	Aquaculture areas	WRBD	Other Disturbances	SWRBD, SERBD, WRBD	Former DCMNR & BIM
Aqua2005.mdb	Database of aquaculture site location and extents, licence status, species. Areas represent licensed area and not necessarily the area 'worked'	RoI	Other Disturbances	former DCMNR	DAFF
FishingGears_08-08-06_region.shp	Location, extents, gear/methods and species targeted of fishing/aquaculture sites. Site extents were defined by the MI following consultation with fishing and aquaculture community/organisations across Ireland. Areas do not necessarily represent the area 'worked'.	RoI	Other Disturbances	MI (& RPS)	MI
ScallopDredgedAreas.shp	Scallop dredge and acoustic data for the SE. Outside TraC water bodies	South East	Other Disturbances	BIM	BIM

Table 3.2(continued): Data Resources: Summary of the information assessed for the purpose of further characterising Dredging, Disposal at Sea and Other Disturbances of Seabed.

File Name/Type	Data Description	Geographic location	Pressure	Sourced from	Data Owner / Originator
15374 2267_BIM Bivalve Fisheries	Bivalve Fisheries (NW, W, E & SE coasts)	NWRBD, WRBD, ERBD, SERBD	Other Disturbances	BIM	BIM
WindFarmZones.shp	Designated Wind Farm Zones	RoI	Other Disturbances	MI	MI
cables_07.shp	Marine cables. Outside TraC water bodies	Ireland (& UK)	Other Disturbances	Oil Field Publications Ltd	DCENR
pipes-06.shp	Marine pipes	Ireland (& UK)	Other Disturbances	Oil Field Publications Ltd	DCENR
wells-07.shp	Marine wells. Outside TraC water bodies	Ireland (& UK)	Other Disturbances	Oil Field Publications Ltd	DCENR
kingfisherCableWgsLine.shp	Location of submarine telecom cables around the Irish coastline	Ireland (& UK)	Other Disturbances	Marine Institute	Kingfisher Information Service / CMRC
Ferries.shp	Ferry Routes	Ireland (& UK)	Other Disturbances	US NIMA	ESRI
15374 2272_Irish dumpsites.xls	OSPAR reported dump sites (2005) - updated dump sites only, no associated dredge information	ROI	Disposal at Sea	MI	MI
15374 1885_Dumping at Sea 1993-2004 (Updated).xls	OSPAR reported dump sites 1993 - 2004 with some updated to 2005	ROI	Disposal at Sea	MI	MI
RBD identified Disposal at Sea locations (shapefile)	Dumping at Sea locations (Collated by RBDs from Marine Institute OSPAR reported dump sites)	ShRBD, ERBD, SERBD, SWRBD, WRBD	Disposal at Sea	RBDs	MI
RBD identified Disposal at Sea locations (MS Excel spreadsheet)	Collated from DCMNR dumping at sea applications	SWRBD	Disposal at Sea	SWRBD	DCMNR/ DCENR
Various pdf	Dumping at Sea Applications, 2006 and 2007	ROI	Disposal at Sea	former DCMNR	DCENR
15374 2268_Foreshore Lic Download.xls	Register of Deeds relating to Foreshore Licences. Accurate location details unavailable. Most recent record October 2005	ROI	All	former DCMNR	DCENR
15374 2288 Fshore 2005-2008.xls	Download of limited foreshore licence details from the DCMNR online database	ROI	All	former DCMNR	DCENR

Methodology for Assessing Dredging, Disposal at Sea and Other Disturbances of Seabed

The following methodology was adopted for assessing Dredging, Disposal at Sea and Other Disturbances of Seabed:

a. Collate all dredging and disposal data received from the RBDs and the EPA to ensure all related attribute information is contained with a national shapefile. This resulted in two shapefiles representing the national findings of the initial risk assessments for both dredging and disposal at sea.

b. Identify which records from the national dredging file are most likely to represent maintenance/capital dredging by removing those associated with aquaculture.

   i. Firstly those records from the national dredge file that were not identical to, but intersected with sites referenced in the former DCMNR 2005 Aquaculture Database were selected.

   ii. From this selection, those records most likely to represent maintenance/capital dredging were identified following a review of the Marine Institute fishing atlas and attribute data supplied by the RBDs.

   iii. A review of foreshore licence records helped identify which sites were most likely maintenance and capital dredge areas, and two shapefiles representing high and low impact dredge areas were generated.

c. Identify additional maintenance/capital dredge areas within TraC water bodies

   i. Shipping Navigation channels: The area of maintained channel for shipping and navigation was used as the basis for maintenance dredge areas. Navigation channels must be maintained for safe navigation, although the frequency of maintenance for these areas is not recorded within this dataset.

   ii. Dumping at Sea applications were reviewed and where possible the area dredged was compared with the shipping navigation channels; none of which lay out side these navigation areas.

   iii. Another potential source of maintenance dredge data is that available through OPW. Those records associated with ‘channels’ were selected for assessment. Information relating to the extent of maintenance of these channels was limited. Ttherefore, to estimate the area of channel/drain maintained the following buffer extents were applied:

      - Channel drains – 4.5m buffer: as the average drain size is 7-9m wide (King, 1996)).
      - Channels – 150m: Based on the maintained channel width average for navigation.
      - Drainage Districts - data from drains and channels from the Drainage District channels dataset (data from the OPW, drainage maintained by Local

Authorities) were selected and buffered as above. The Fane estuary main channel was identified from 2007 Central Fisheries Board (CFB) surveys and ecological data as a maintained buoyed channel. The channel was therefore buffered at 150m though not identified as such from the provided attribute data.

The buffer sizes were determined by assessment of channel and drain information from OPW papers (such as scheme summaries on the OPW website and King, 1996) and in agreement with the Steering group.

iv. The foreshore licence/lease register was consulted and any additional dredge areas and/or information of relevance to the identified dredged areas was added to the national dredge file. A channel was added in the New Ross water body consisting eight capital dredge polygons forming a channel. This had been identified as a capital dredge operation, but is now maintained for navigation and was therefore transferred to the shipping channels dataset with the agreement of the Steering Group.

v. No additional capital (high impact) dredge areas were identified

d. Those associated with shipping and drainage channel maintenance were merged with those identified in the initial risk assessments to generate a national file of maintenance (low impact) dredge areas.

e. Identify pressure footprints for 'Other Disturbances to Seabed' - Shellfish dredging & trawling.

i. To identify sites dredged or trawled for shellfish those records identified from the Marine Institute fishing atlas as dredged and trawled with a shellfish targeted species were firstly selected. No trawling sites were targeted at shellfish species.

ii. The former DCMNR 2005 aquaculture database does not specify the aquaculture method used for each site. Therefore, it was assumed that aquaculture sites which intersected with the shellfish dredge areas identified from the Marine Institute fishing atlas represented licensed dredged shellfish areas. Sixty three sites were identified.

iii. National bivalve fishery areas were obtained from BIM. Using attribute data supplied, those areas annotated by 'dredging' were selected for assessment.

iv. The sites identified by the steps above overlap in many areas. Also, the site boundaries do not necessary mark the 'worked area' but where these activities are licensed to take place. It was therefore considered most appropriate to 'union' all sites within ArcGIS. This step ensures that sites that overlap do not result in a double-up in footprint area. For example, if sites from BIM and Marine Institute overlapped for $2km^2$; this $2km^2$ is only counted once as a footprint but records the attribute information from both sources.

f. Identify pressure footprints for 'Other Disturbances to Seabed' – pipelines, cables and vessel movements.

i. Data for marine cables and pipelines was received in polyline format, but excluded information relating to the width of these structures. Therefore, to estimate the area potentially affected buffers were created for each structure as follows:
   - Kingfisher cables: 25m (based on the potential zone of impact for laying and scour action for surface cables (ABpMer, 2002)
   - Pipelines: 50m (based on the potential zone of impact for laying and scour action or rock armour impact for pipelines)

ii. Ferry routes were buffered to 150m (based on the average maintained channel width for navigation channels)

g. Finalise 'Other Disturbances to Seabed'

i. Footprints for the following pressure types were merged to create the final Other Disturbances to Seabed file:
   - Shellfish dredge areas
   - Buffered cable and pipelines
   - Designated wind farm areas
   - Buffer ferry routes

ii. Cables, pipes, ferry routes, and wind farms all represent additional pressures to shellfish dredge areas. Therefore, where these sites overlap the pressure footprints will double for that area.

3.2.2.2 Piled, Flow and Sediment Manipulation Structures

For the purpose of this study piled structures are defined as 'structures raised on one or more foundation structures extending out into the adjacent water body e.g. bridge and pier supports' (SEPA et al (in press)). Flow and sediment manipulation structures are defined as 'hard engineering structures built to stabilise waterways for navigation and counter the effects of longshore drift' SEPA et al (in press)) such as piers, groynes and training walls.

Data Resources

The information assessed for the purpose of further characterising piled and flow and sediment manipulation structure is summarised in Table 3.3. The following section outlines the data assessed by the source organisation

River Basin District Initial Risk Assessment

Ports and harbours were assessed as part of the pressure 'Built Structures'. The location, port name and tonnage were presented in point shapefiles. Further characterisation of 'Built Structures' required the identification of the type and extents of structures associated with these ports and harbours.

Marine Institute

The Marine Institute, in partnership with Donegal, Mayo and Galway County Councils have made available via an online National Coastal Infrastructure Service details of piers, quays, harbours and slipways. A database of these structures including additional unreleased data for County Cork was acquired from the Marine Institute for assessment of flow and sediment manipulation structures. Due to the nature of the National Coastal Infrastructure Service only specific information can be queried for external release; the following information was obtained:

- Structure name
- Structure type
- Width (m)
- Length (m)
- Location

As with the information collated for the initial risk assessments, this dataset displayed as point locations. However, measurements for structure width and length were provided for approximately 75% of the records. In addition to anthropogenic structures this dataset also included natural landing sites which were excluded from the assessment.

Coastal and Marine Resource Centre

Datasets relating to the location of ports, harbours, marinas, and sailing clubs were obtained from the Coastal and Marine Resource Centre (CMRC). Additional information provided for these locations included traffic volume, route and service information. Further characterisation of pressures associated with these navigational sectors required the extents of specific structures such as piers or jetties to be digitised.

Table 3.3: Data Resources - Summary of the information assessed for the purpose of further characterising piled and flow and sediment manipulation structure

This table outlines the information used to assess the pile, flow and sediment manipulation structures. This data was verified and expanded supported by the baseline information in Table 3.1

File Name/Type	Data Description	Geographic location	Pressure	Sourced from	Data Owner / Originator
port_tonnage.shp	ERBD Port name and tonnage, no structure details	ERBD	Flow/Sediment manipulation structures	ERBD	ERBD
Ports_Harbours.shp	SERBD port name and tonnage, no structure details	SERBD	Flow/Sediment manipulation structures	SERBD	SERBD
Ports_Structures_point.shp	Structure type and tonnage defined for some records	ShRBD	Flow/Sediment manipulation structures	ShRBD	ShRBD
Ports&Harburs.shp	Created layer based on the information contained in the CSO document "Statistics of Port Traffic" for the risk assessment. Port name and tonnage, no structure details	SWRBD	Flow/Sediment manipulation structures	SWRBD	SWRBD
WRBD_Ports_point.shp	Port location only, no structure details	WRBD	Flow/Sediment manipulation structures	WRBD	WRBD
NS_Harbours_etc.2.shp	NS Coastal features such as jetties and piers. Attribute date includes structure type and title of oblique images used to identify structure	NSS	Flow/Sediment manipulation structures	NS-Share	NS-Share
NS_Ports.shp	NS Point location of ports, no structure details	NSS	Flow/Sediment manipulation structures	NS-Share	NS-Share
15374 2271_Coastal Structures Rev3.xls	Location of piers, quays, harbours and slipways collated for the National Coastal Infrastructure Service. Details of areal extents are provided for many structures. Information for counties Donegal, Mayo and Galway is available at coastal i.e as part of a data release from the first stage of the project. Further releases will include information for other counties. Data received included unreleased data for county Cork	Galway, Mayo, Donegal and Cork	Flow/Sediment manipulation structures	MI	MI; Donegal; Mayo; Galway; & Cork CoCo
intFerryPorts.shp	Location of ports and route information	Ireland	Flow/Sediment manipulation structures	CMRC	CMRC
localFerryPorts.shp	Location of ports and route information	Ireland	Flow/Sediment manipulation structures	CMRC	CMRC

Table 3.3(continued): Data Resources - Summary of the information assessed for the purpose of further characterising piled and flow and sediment manipulation structure

File Name/Type	Data Description	Geographic location	Pressure	Sourced from	Data Owner / Originator
marinas.shp	Marinas, pontoons, mooring, sailing, berths	Ireland	Flow/Sediment manipulation structures	CMRC	CMRC
rnliStations.shp	Location of lifeboat stations and information on services available	Ireland	Flow/Sediment manipulation structures	CMRC	Royal National Lifeboat Institution
commercialPortsIE.shp	Generalised locations of ports, traffic volume (2005)	ROI	Flow/Sediment manipulation structures	CMRC	CMRC
fishingPortsIE.shp	Location of ports	ROI	Flow/Sediment manipulation structures	CMRC	CMRC
sailingClubIsa.shp	Location and other relevant information about Irish Sailing Association (ISA) member sailing clubs	ROI	Flow/Sediment manipulation structures	CMRC	CMRC
Merge_embed_26_1_04.shp	CMRC Cork Harbour Study: Merged information on shoreline features such as jetties and piers, human access points (steps & ladders)	Cork Harbour	Flow/Sediment manipulation structures	SWRBD	CMRC
Merge_ship_26_1_04.shp	CMRC Cork Harbour Study: Information on the shipping related features of shoreline, such as dock or shipyard	Cork Harbour	Flow/Sediment manipulation structures	SWRBD	CMRC
Bridge DD V1	Location of OPW Drainage District bridges. Point shapefile indicating location	RoI	Piled structures	SWRBD	OPW

Methodology for Assessing Piled, Flow and Sediment Manipulation Structures

The following methodology was adopted for assessing Piled, Flow and Sediment Manipulation Structures:

a Firstly, those coastal structures identified by the Marine Institute database lacking areal measurements were reviewed using orthophotos and oblique images. Where identified, these structures were digitised and the relevant attribute information extracted.

b The orthophotos and oblique images were then used to review the remaining data sources listed in Table 3.1 above. Where orthophotos were available; the extents of identified structures were digitised.

c On completion of this step, urban and industrial areas as identified by the EPA CORINE were reviewed for any additional structures. The OPW records for bridges were also reviewed and additional piled structures were digitised.

Oblique images were not available to confirm the presence of all piled structures particularly those in upstream tidal channels.

3.2.2.3 Shoreline Reinforcement

Shoreline reinforcement structures are defined as two different structure types for the purpose of further characterisation and assessment within TraC-MImAS:

- Shoreline reinforcement – High Impact: "The use of consolidated materials, e.g. rock armour, revetments, retaining walls, gabion baskets, seawalls, wharves, sheet piling etc. to protect vulnerable coastlines or harbours from erosion". (SEPA et al (in press)) Refers to situations were the reinforcement is having a persistent influence over the intertidal or subtidal zone.
- Shoreline reinforcement – Low Impact: "Stabilisation of the shoreline using beach material to maintain beach levels and dimensions. May include use of synthetic materials. Also includes other forms of low impact shoreline protection, for instance protection that is set back and does not have a persistent influence over the intertidal or subtidal zones." (SEPA et al (in press))

Data Resources

A registered national database of coastal defence and protections structures is not available for Ireland. However, the former DCMNR Engineering Division hold paper records of structures licensed for construction but it was not practical to consult this data on a national scale appraisal.

The following resources (Table 3.4) were used to focus the review of Ireland's coast for shoreline reinforcement structures. Additional features were also digitised where identified during the assessment of other pressures.

- Existing records of shoreline reinforcement type structures as provided by the RBDs
- Urban and industrial areas (as identified by the EPA CORINE 2000 land use dataset)
- Ortho and oblique photos, where available; and
- Foreshore licence records (shoreline reinforcement – low impact; beach nourishment)

River Basin District Initial Risk Assessment

Coastal defence features were identified in the initial risk assessments following the review of coastal images produced by the former DCMNR Coastal Helicopter Survey (SnapMap Project) and collated by the EPA into a national coastal defence shapefile for the purpose of reporting. Records identified in the initial risk assessments for the WRBD and NWRBD were not received for this Study and were absent from the national shapefile.

The RBD datasets contain a mixture of coastal defence structures, all of which do not represent shoreline reinforcement as defined for this study but pressures of a different sort e.g. embankments.

Coastal and Marine Resource Centre

The CMRC completed a Coastal Inventory project for Cork Harbour. As part of this project the shoreline features of the following areas of Cork Harbour were identified and mapped; Upper West and Mid Harbour, East Ferry, West Passage, Spike/Cobh, Whitegate, and Owenabue. These areas of shoreline fall into the following WFD water bodies:

- Lee (Cork) Estuary Upper and Lower (SW_060_0950 and SW_060_0900);
- Lough Mahon (SW_060_0750);
- Lough Mahon (Harper's Island) (SW_060_0700);
- North Channel Great Island (SW_060_0300);
- Cork Harbour (SW_060_0000); and
- Owenboy Estuary (SW_060_1200)

The information provided by CMRC to Cork County Council (and SWRBD) is bound by the following copyright:

"***The data contained on this CD can not be copied, utilised or disseminated in any way without prior written consent from the CMRC. Many of the datasets contained on the CD are used under licence from other agencies, information on the licences can be got by contacting the CMRC***".

Data produced by this project and provided by the SWRBD was incorporated into the Marine Morphology study for the assessment of shoreline reinforcement in those water bodies outlined above. However, permission must be sought from the CMRC prior to the use of this data by other bodies outside Cork County Council (and SWRBD).

The former Department of Communications, Marine and Natural Resources

RPS Consulting Engineers are currently undertaking a flood risk study on behalf of the former DCMNR. Discussions with RPS concluded that 'at risk' areas have been identified for Ireland's coast and it is the intention of this study to identify existing coastal defence/protection in these areas. At the time of writing, those structures for 'at risk' areas along the eastern Irish coastline were identified, however, release of this data was not permitted until completion of the project.

Table 3.4: Data Resources - Summary of the information assessed for the purpose of further characterising Shoreline Reinforcement Structures

File Name/Type	Data Description	Geographic location	Sourced from	Data Owner / Originator
Merge_hard_26_1_04	CMRC Cork Harbour Study: Merged information on shoreline engineering such as sea walls and revetments	Cork Harbour	SWRBD	CMRC
erbd_coastal_structures	Coastal defence features identified by the initial risk assessments. The former DCMNR SnapMap service was referred to in identification of these structures. Contains linear features: mixture of defence, flow/sediment and embankment structures	ERBD	ERBD	ERBD
NS_Coastal_Defence	Coastal defence features identified by the initial risk assessments. The former DCMNR SnapMap service was referred to in identification of these structures. All features recorded as 'coastal defence' but no further detail provided	NSS	NS-Share	Former DCMNR/RPS
coastal_defence_national	National dataset of coastal defence structures identified by the RBDs in the initial risk assessments. Collated by the EPA. Structure type is defined for approximately half the records.	ROI	EPA	EPA/ Former DCMNR/RPS
COASTAL DEFENCE	Coastal defence features identified by the initial risk assessments. The former DCMNR SnapMap service was referred to in identification of these structures. Contains linear features: mixture of defence, flow/sediment and embankment structures	SERBD	SERBD	Former DCMNR/RPS
Coastal_Defence_polyline	Coastal defence features identified by the initial risk assessments. The former DCMNR SnapMap service was referred to in identification of these structures. Contains linear features: mixture of defence, flow/sediment and embankment structures	ShRBD	ShRBD	Former DCMNR/RPS
Coastal_Defences	Coastal defence features identified by the initial risk assessments. The former DCMNR SnapMap service was referred to in identification of these structures.	SWRBD	SWRBD	Former DCMNR/RPS
CoastalDefenceEndPt.	End points used to determine length of coastal structure	SWRBD	SWRBD	Former DCMNR/RPS
CoastalDefenceStartPt.	Start points used to determine length of coastal structure	SWRBD	SWRBD	Former DCMNR/RPS
Harbours,Slips,Etc	Point locations of shoreline reinforcement information; no harbours, piers listed - identified by the initial risk assessments. The former DCMNR SnapMap service was referred to in identification of these structures. Structure types specified	SWRBD	SWRBD	Former DCMNR
15374 2268_Foreshore Lic Download.xls	Register of Deeds relating to Foreshore Licences. Accurate location details unavailable. Most recent record October 2005	ROI	former DCMNR	DCENR

Methodology for Assessing Shoreline Reinforcement

The following methodology was adopted for assessing Shoreline Reinforcement:

a All existing records of shoreline reinforcement type structures were firstly collated. These records were then reviewed, verified and/or edited using the coastal imagery resources.

b Where structures were not identified by the resources listed in Table 3.4 above a search for additional structures was focused within areas identified as urban or industrial using the EPA CORINE 2000 land use dataset.

c The foreshore licence/lease register was reviewed within ArcMap for areas of potential beach nourishment (shoreline reinforcement – low impact), two of which were identified:

- MS51/8/2 Vol 7: Removal of sand for the purpose of nourishing the Beach at Bantry (1985)
- MS51/8/984: Bere Island beach nourishment (1996)

This register does not provide detail relating to the extent of these activities therefore, the footprints for these pressures could not be digitised.

d Following reference to the coastal imagery resources and the pressure footprint description detailed in the introduction above, the structure 'type' and an impact rating of 'High' or 'Low' was then assigned to each feature

e Where the likely impact of a seawall structure could not be confirmed by coastal imagery, an impact rating of 'High' was assigned as a conservative default.

3.2.2.4 Flood Embankments

Flood Embankments are defined for the purpose of further characterisation and assessment within TraC-MImAS as "An artificial bank of earth or stone created to prevent inundation of estuarine and coastal floodplains". (SEPA et al (in press))

Data Resources

The data resources for flood embankment assessments are summarised in Table 3.5 below.

River Basin District Initial Risk Assessment

The information used to report on flood embankments for the initial risk assessments was obtained using data provided by the OPW and also a review of the former DCMNR coastal oblique images. As noted in Section 3.2.2.1 (Dredging – Data Resources) above the OPW released an updated revision of the GIS layer Drainage Scheme Embankments in 2005.

Embankment datasets received from the RBDs were for the most part generated from the superseded 2004 OPW dataset which incorporated additional records to those contained within the 2005 revision, including line features representing the location of lands benefiting from embankments. With respect to the request from OPW not to use the 2004 data those records provided by the RBDs were clarified with the OPW 2005 dataset and/or coastal imagery prior to inclusion as pressure footprints.

OPW requested that the following colour format be utilised for 2005 revision of Drainage Embankments:

- Line 3 pixels thick; Colour green (red: 0, green: 125; blue: 0)

Following discussions with OPW relating to additional embankments identified, OPW asked to be notified of any errors or new embankments identified on completion of this project.

Table 3.5: Data Resources - Summary of the information assessed for the purpose of further characterising embankments

This table summarises the data assessed for the creation of the embankment data. The data is predominantly collated by local authorities and the OPW.

File Name/Type	Data Description	Geographic location	Pressure	Sourced from	Data Owner / Originator
Impoundment	Impoundment locations labelled RWB or TWB - one record relevant to TWB (Broadmeadow Water Estuary / Malahide Bay)	ERBD	Impounding Structures	ERBD	ERBD
Impoundments	One feature identified: Tacumshin Lake	SERBD	Impounding Structures	SERBD	SERBD
Tidal_Barrages	One feature identified: River Fergus tidal barrage	ShRBD	Impounding Structures	ShRBD	ShRBD
Tidal_Barrages	Six features identified, includes detail of fish passage.	SWRBD	Impounding Structures & Causeways	SWRBD	SWRBD
ESB_Hydro_Scheme	Location and name only, of dams, reservoirs and hydroelectric stations. Outside TraC waters	WRBD	Impounding Structures	WRBD	WRBD
WRBD_Impoundments_point	Location only of impoundments. Outside TraC waters	WRBD	Impounding Structures	WRBD	WRBD
15374 2255_CFB Impassible Barriers	Central Fisheries Board Impassable Barriers	ROI	Impounding Structures	ShRBD	CFB
Sluice_Scheme	OPW 2004 data	ROI	Impounding Structures & Causeways	SWRBD	OPW
Weirs_Scheme	OPW 2004 data	ROI	Impoundment	SWRBD	OPW

Methodology for Assessing Flood Embankments

The following methodology was adopted for assessing Flood Embankments:

a Features identified as embankments in the RBD coastal defence datasets (SERBD and NSS) were collated with those embankment datasets received from the SWRBD and WRBD (OPW 2004 data).

b Embankment records from the OPW 2005 dataset were compared with those records provided by the RBDs to identify those features additional to the OPW 2005 data.

c Additional records identified were then assessed in conjunction with coastal images and foreshore licence records to focus review for additional embankment features.

d New embankment features were only digitised in areas for which orthophotos were available.

e Ten foreshores licence records were identified as relating to embankments:

- North Bull Island (MS51/4/108): embankment digitised
- Boyne Estuary (no reference number provided): Embankments are digitized within this water body; however, their association with this particular licence cannot be confirmed.
- New Ross Port & Barrow Suir Nore Estuary (four records; MS51/6/150, MS51/1/64): The OPW 2004 dataset includes embankments at two locations in these water bodies. Also, on review of the EPA Envision online mapper, embankments are evident in area. However, due to the lack of orthophoto coverage and oblique images for these areas embankments were not digitized.
- Cork Harbour (Aghada): specific embankments were not identified for this area, however land claim pressures were identified for this area (near Electricity Supply Board (ESB)), a component of which may be embankments (near ESB).
- Lough Mahon (Marino Point – MS51/8/541; and Little Island – MS51/8/429): Area at Marino Point is reclaimed therefore embankments were not required to be digitised; however embankments at Little Island were added to the pressure file.
- Lower Shannon Estuary (Tarbert - MS51/9/213): these features are included in the OPW 2005 dataset (Unique ID: 7792).

f As additional embankments to those recorded by the OPW (2005) were digitised where identified using orthophotos, the colour format recommended for use by OPW was not adopted for this pressure as a whole. However, the source of each feature contained within the resulting pressure dataset was annotated as follows so that those features representing records sourced from the OPW (2005) can be identified:

<u>Records added / retained:</u>

- “Article 5 –Coastal defence”: sourced from RBD coastal defence shapefiles
- “Article 5 & Orthophotos”: features additional to OPW datasets identified in Art 5 initial risk assessments and clarified using orthophotos.

- "Article 5, Ortho & Obliques photos": features additional to OPW datasets identified in Art 5 initial risk assessments and clarified using ortho and oblique photos.
- "OPW 2005 & Orthophotos"
- "OPW 2005, Ortho & Oblique photos"
- "OPW_Oct_2005": Sourced from OPW 2005 dataset, but extents not be clarified by ortho or oblique images due to lack of coverage
- "Ortho & Oblique Photos": new features identified by orthophotos and oblique images
- "Orthophotos": new features identified by orthophotos only

Records excluded:

- "Diff to OPW 2005 – breached – Delete": embankment is contained within the OPW 2004 dataset but is currently breached and therefore not functioning as a flow manipulating feature
- "Diff to OPW 2005 & no Orthos – Delete": no orthophotos were available to confirm the presence or extents of embankments
- "Diff to OPW 2005 & unclear in Orthos – Delete" resolution of orthophotos prevented confirmation of the presence or extents of embankments

3.2.2.5 Impounding Structures & Causeways

Impounding Structures and Causeways are defined as follows for the purpose of further characterisation and assessment within TraC-MImAS:

- **Impounding Structures**: A temporary (e.g. barrage) or permanent structure that extends across a channel that is used to impound, measure or alter flow (e.g. weirs, sluices).
- **Causeways**: A physical barrier projecting from the shore whose foundations extend to the bed and where gaps in the foundings represent < 20% of the total length. Typically used to support transport routes.

The pressure 'footprint' required for assessment of causeways within TraC-MImAS is the total area (km) of each structure identified. Also, the proportion of this footprint within the intertidal and subtidal zones must be estimated.

The footprint required for the assessment of impounding structures within TraC-MImAS was not confirmed as part of the UKTAG hydromorphology work and it was concluded that each agency applying TraC-MImAS should review potential footprint rules. Work undertaken to date to help determine a suitable impact rating for impoundments on TraC waters is discussed further in Chapter 5. Discussions with the Irish Marine Morphology Steering

Group concluded the following in relation to the assessment of impounding structures within TraC-MImAS:

- The Marine Morphology Steering Group advised that where historic impoundments are the likely cause of WFD water bodies delineated as 'lagoons' (TW6 and CW10), these impoundments should not be assigned as pressures on the lagoon, e.g. Durnesh Lough and Inch Lough.
- The pressure footprint agreed with the Steering Group for assessment with TraC-MImAS is the area of water body impounded by a structure. Adoption of this method however, prevents those structures identified at the landward boundary of TraC waters, such as embankment sluices, being assessed within MImAS, as the area of water impounded is outside the TraC boundaries. Such pressures will be identified by the either the Freshwater Morphology or Hydrometric PoMS studies. However, to ensure the consideration of all relevant pressures on TraC water bodies identified structures of this character will be reported on, where relevant, separately to MImAS.

Data Resources

The information used in the assessment in the assessment of impoundment structures and causeways is summarised in Table 3.6. The data was received from the organisations listed below.

River Basin District Initial Risk Assessment

The following resources were used to collate information relating to impounding structures for the initial risk assessments:

- Local Authority information and local knowledge (tidal barrages)
- Central Fisheries Board (CFB) dataset of impassable barriers: This dataset was prepared as part of the study completed by the Central Fisheries Board and Compass Informatics and compiled in the report "Quantification of the Freshwater Salmon Habitat in Ireland" (Mc Ginnity ***et al***, 2003). This dataset has very limited attribute information but represents two types of barriers impassable to salmon:
  - Non-self sustaining salmon systems. Digitised points identify the location of the four main hydroelectric dams (Liffey, Lee, Shannon, and Erne catchments).
  - 'Complete' - These are other locations considered to limit salmon migration and represent a mixture of manmade and natural features. Although the feature types are not identified by the attribute table, it is considered that most records represent natural barriers such as waterfalls.

  As part of the Freshwater Morphology PoMS, a barrier impact assessment case study was initiated in 2007 throughout the Nore catchment using data collected by the Southern Regional Fisheries Board. The purpose of the Nore study is to assess the risk of in-river structures to the timing and success of salmon migration. The Freshwater Morphology Group is seeking to build on the existing CFB database of impassable barriers in order to progress the WFD barriers study.

Office of Public Works Sluice & Weir Data

In addition to OPW data relating to drainage channels and embankments, the 2004 OPW dataset obtained via the SWRBD contained national records of sluice and weir locations (which were not updated in 2005). These datasets were not considered for the initial risk assessments.

The OPW have requested that these datasets are not interpreted to represent accurate structure locations as they have yet to be fully quality audited (Nathy Gilligan, personal communication, Feb 2008). OPW are currently reviewing their national data - a final dataset for sluice and weir structures will not be available within the next year.

For the purpose of further characterisation, the pressure of these structures on TraC water bodies for the most part is outside TraC-MImAS i.e. the footprint agreed for such impounding structures, being the area of water body upstream of the structure, is mostly represented by freshwater channels or drains.

Table 3.6: Data Resources - Summary of the information assessed for the purpose of further characterising Impoundments.

The following table outlines the data assessed to create a national impoundment pressure layer. The information was checked and verified from the baseline data (Table 3.1) where there was sufficient coverage.

File Name/Type	Data Description	Geographic location	Pressure	Sourced from	Data Owner / Originator
Impoundment	Impoundment locations labelled RWB or TWB - one record relevant to TWB (Broadmeadow Water Estuary / Malahide Bay)	ERBD	Impounding Structures	ERBD	ERBD
Impoundments	One feature identified: Tacumshin Lake	SERBD	Impounding Structures	SERBD	SERBD
Tidal_Barrages	One feature identified: River Fergus tidal barrage	ShRBD	Impounding Structures	ShRBD	ShRBD
Tidal_Barrages	Six features identified, includes detail of fish passage.	SWRBD	Impounding Structures & Causeways	SWRBD	SWRBD
ESB_Hydro_Scheme	Location and name only, of dams, reservoirs and hydroelectric stations. Outside TraC waters	WRBD	Impounding Structures	WRBD	WRBD
WRBD_Impoundments_point	Location only of impoundments. Outside TraC waters	WRBD	Impounding Structures	WRBD	WRBD
15374 2255_CFB Impassible Barriers	CFB Impassable Barriers	RoI	Impounding Structures	ShRBD	CFB
Sluice_Scheme	OPW 2004 data	RoI	Impounding Structures & Causeways	SWRBD	OPW
Weirs_Scheme	OPW 2004 data	RoI	Impoundment	SWRBD	OPW

Methodology for Assessing Impounding Structures & Causeways

The following methodology was adopted for assessing Impounding Structures & Causeways:

a Using the resources outlined above the locations of the impounding structures/tidal barrages identified in the initial risk assessments were reviewed.

ERBD

- One structure of those identified in the initial risk assessment is relevant to TraC waters (Broadmeadow Water Estuary / Malahide Bay). The Marine Morphology Steering Group advised that impoundments should not be assigned to lagoons created by historic impoundment (Broadmeadow Water). However, as this impounding structure has not 'land-locked' the Broadmeadow Water it was considered appropriate to represent this feature as a flow and sediment manipulation structure joined to a piled structure; both of which were assigned to the downstream water body Malahide Bay (EA_060_0000).

SERBD

- Tacumshin Lake impoundment was identified by the SERBD. A review of the historic maps and oblique images indicated that the impoundment of this water body is attributed to natural deposition of material which has created a barrier of dunes. Taking account of this information and the Marine Morphology Steering Group advice an impoundment structure was not digitised.

WRBD

- All features identified by the WRBD lay outside TraC water body boundaries.

ShRBD

- One structure was identified by the ShRBD; Fergus Tidal Barrage. This structure falls outside TraC boundaries and therefore is not digitised. This structure, however, is assessed by the HMWB PoMs study as the freshwater bodies upstream of this structure are designated as provisionally heavily modified.

SWRBD

- A 'tidal barrage' (with fish passage) was identified in Roaring Water Bay, however, on review of coastal imagery, this structure was digitised as piled structure not an impoundment.
- A 'tidal barrage' identified in Outer Cork Harbour (Roberts Cove) was digitised as a Causeway following a review of coastal imagery.
- A 'causeway' identified in Cork Harbour (cuskinny river) was confirmed and digitised.
- A record identified as 'sluice on lake' in Rostellan Lake was digitised as a causeway in Cork Harbour

- A record identified as a 'sluice/tidal barrage' in Lough Mahon (Slatty Bridge) was digitised as a combination of flow/sediment manipulation and pile structures following review of coastal imagery.
- The presence of a 'tidal sluice' identified in Lower Black Water M Estuary was confirmed. However, this structure was not digitised as the body of water potentially impounded by this structure is not within the transitional water body boundary.

b Using coastal imagery and the additional data resources outlined in Table 3.6 above, a search for impounding structures and causeways was undertaken. No additional impounding structures were identified and many of those recorded by the initial risk assessments were located outside TraC waters or where present were characterised as flow and sediment manipulation structures, causeways or piled structures.

3.2.2.6 Land Claim

Land Claim and Tidal Channel Realignment pressures are defined as follows for the purpose of further characterisation and assessment within TraC-MImAS:

- **Land claim - High impact**: Recent or proposed enclosure of intertidal or subtidal areas within impermeable banks followed by infilling for use by agriculture, housing, port or industry. Also used for land claim that has taken place in the past and is still deemed to be having a significant impact.
- **Land claim - Low impact**: Historic (e.g. >50yrs ago) enclosure of intertidal or subtidal areas within impermeable banks followed by infilling for use by agriculture, housing, port or industry. Can also be used for more recent land claim where the impacts are minimal or where the surrounding environment has partly recovered natural habitats and features.
- **Tidal channel realignment - High impact:** Recent or proposed realignment of a tidal channel. Also used for realignment that has taken place in the past and is still deemed to be having a significant impact.
- **Tidal channel realignment - Low impact:** Low impact alterations to course or planform of upper estuaries where the channel remains river-like. Includes straightening and removal of meanders to increase channel gradient and flow velocity. Typically used to cover historic work (e.g. >50yrs ago) and where the channel has partly recovered natural habitats and features.

The pressure 'footprint' required for assessment of Land Claim and Tidal Channel Realignment within TraC-MImAS is the total area (km^2) reclaimed. Also, the proportion of this footprint within the intertidal and subtidal zones must be estimated.

Data Resources

The following resources were used to investigate the location and extent of land claim and tidal channel realignment, details of which are outlined in Section 3.2.2.6 and 3.2.2.3 above:

- Coastal imagery: orthophotos and oblique images
- Historic maps: georeferenced bedrock maps provided by the GSI
- EPA CORINE Land Cover 2000 database
- Foreshore licence records
- Environmental Impact Statements

Methodology used to assess Land Claim

The following methodology was used to assess Land Claim:

a The review of Ireland's coast for land reclamation and tidal realignment for the most part focused on urban and industrial areas (as identified by the CORINE dataset) as well as the locations of foreshore licence and EIS records. However, additional areas were digitised where these had been identified during the review of other pressures types.

b Using numeric grids provided by RBDs (via OSi) and the GSI, the images for both orthophotos and historic maps required for assessment were identified, and by overlaying these images changes in coastal lands could be identified. The estimated extents of reclaimed areas were digitised only where orthophotos and historic images were available. No areas of tidal realignment were identified.

c For each area digitised an impact rating of High or Low was assigned based on the footprint definitions outlined above. Due to the lack of background information associated with reclaimed areas the age of land alteration is unknown in most cases. Therefore, when assigning 'High' or 'Low' impact the likely ability of surrounding environments to recover was considered as a prominent indicator.

d Following agreement with the Marine Morphology Steering Group, the whole area of 'Clogheen Strand' coastal lagoon water body (SW_100_0400) was assigned to land claim.

e On assessment of the pressure land claim within TraC-MImAS the estimated area of a water body prior to reclamation should be considered as the total water body area impacted by the land claim identified. However, it must be noted that reclaimed areas identified by this study date both before and after the delineation of the WFD water body boundaries. Where land claim has occurred prior to the delineation of water body boundaries this area is added to that of the water body to estimated the total 'original' water body area that this pressure has impacted on. Land claim which has occurred post water body delineation is considered a new pressure on the water body area.

f The water body area entered into TraC-MImAS should be the sum of the existing water body area (as defined by the EPA) and the estimated area of land claim.

3.2.2.7 Intensive Land Use

For the purpose of the initial risk assessments, the EPA CORINE Land Cover 2000 data was used to estimate the risk associated with ILU bordering transitional water bodies. Risk categories were assigned based on the proportion of a water body shoreline flanked with the following land cover types:

- Exploited bogs;
- Urban fabric;
- Industrial, commercial, transportation;
- Coniferous forestry; and
- Arable lands.

An identified land cover type inherently contains many of the more specific and distinct pressures that have been identified and reviewed in more detail throughout the Marine Morphology study. For example, the pressures of ‘Land Claim’ and ‘Flow and Sediment Manipulation Structures’ can be related to urban and industrial land cover types, such as the development of port infrastructure, and these specific pressures have been digitised where identified in areas of orthophotos coverage.

The development of TraC-MImAS originally focused on its use in the assessment and regulation of engineering type pressures and did not consider those pressures associated with coastal land use. Therefore, pressure footprints of other land cover types such as arable land and peat exploitation have not been quantified for assessment within TraC-MImAS. However, its was agreed with the Steering Group that the proportion of TraC shoreline bordering each of the land cover types noted above should be reported on separately in MImAS so as to ensure that the potential risk of activities associated with these land covers is considered for the PoMS. The extent of each land cover type bordering Irish TraC waters is defined in Chapter 5.

Following agreement with the Marine Morphology Steering Group, the assessment of salt marsh grazing as an intensive land use pressure was also excluded from TraC-MImAS assessment within this Marine Morphology study. This pressure is discussed further in Chapter 5 and 6.

Data Resources

Table 3.7 below lists the two layers of Corrine data assessed to determine intensive land use adjacent to the TraC water bodies.

Table 3.7 Summary of the information assessed for the purpose of further characterising Intensive Land Use

File Name / Type	Data Description	Geographic location	Data Owner / Originator
clc00_ie.shp	RoI land cover types defined to level 3 detail – all land use types as identified by the CORINE project detailed to 'level 3'	RoI	EPA
clc00_lev6.shp	RoI land cover types defined to level 6 detail – land use types were further characterised for Pasture and Peatbog land used, detailing these to 'level 6'	RoI	EPA

Methodology used to Assess Intensive Land Use

The following methodology was used to assess Intensive land Use:

a Similarly to the initial risk assessment method; a buffer of 50m was created around the Irish coastline (created from the inverse of TraC water bodies) in order to estimate the length of shoreline bordering intensive land use types.

b The CORINE land cover codes queried are detailed in the Table 3.8 below. Those Corrine codes that are shaded represent the areas assessed as intensive land use

Table 3.8: Selected Corine Land Cover codes by level of detail

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1. Artificial surfaces	1.1 Urban fabric 1.2 Industrial, commercial and transport units	1.1.1 Continuous urban fabric 1.1.2 Discontinuous urban fabric 1.2.1 Industrial and commercial units 1.2.2 Road and rail networks and associated land 1.2.3 Sea Ports			
2. Agricultural areas	2.1 Arable land	2.1.1 Non-irrigated arable land 2.1.2 Permanently irrigated land 2.1.3 Rice fields			
3. Forest and semi-natural areas	3.1 Forests	3.1.2 Coniferous forests			
4. Wetlands	4.1 Inland wetlands	4.1.2 Peat bogs	4.1.2.1 Raised 4.1.2.2 Blanket	4.1.2.1.1 Exploited 4.1.2.2.1 Upland 4.1.2.2.2 Lowland	4.1.2.2.1.1 Exploited 4.1.2.2.2.1 Exploited

c The following attributes were identified for each water body:

- Total water body shoreline length
- Shoreline length bordering each land use

- proportion of water body length bordering each land use per tidal zone
- % water body shoreline bordered by each land use

3.2.2.8 Abstractions

Data resources

Table 3.8 lists the main records assessed to establish the presence of marine surface water abstraction. In addition, searches of available information and consultation were carried out to assess whether there were any additional marine abstractions in Ireland.

River Basin District Initial Risk Assessment

The initial dataset received as part of the Article 5 characterisation has no marine abstractions listed; however, updated information from ongoing work by the River Basin Districts was requested. A data set received from the WRBD had four marine abstraction records in the Shannon. On closer examination of the attribute information it appeared that these records corresponded to only two licences, both listed under the same facility. The abstractions were listed for an aluminium plant in the Shannon (Figure 3.12) and corresponded to the updated WFD Schema data. The licences are in the order of 30,000m^3 according to the IPPC data from the EPA WFD Schema data information. As a result abstractions were not produced as a separate pressures layer, as all the points were within a single water body. However, where relevant, information would be provided in the water body summary sheets. Chapter 8 gives more information on future abstraction pressures. SWRBD also provided a dataset for abstractions. On examination, none were marine.

Environmental Protection Agency

Abstractions data was received from the EPA as part of the WFD Schema geodatabase.
After careful examination of the dataset, only one marine abstraction site was recorded in the database and corresponded with WRBD data. The IPPC (Integrated Pollution Prevention and Control) information within the WFD schema was interrogated for more information and the records corresponded to a single facility in the Shannon (Figure 3.12).

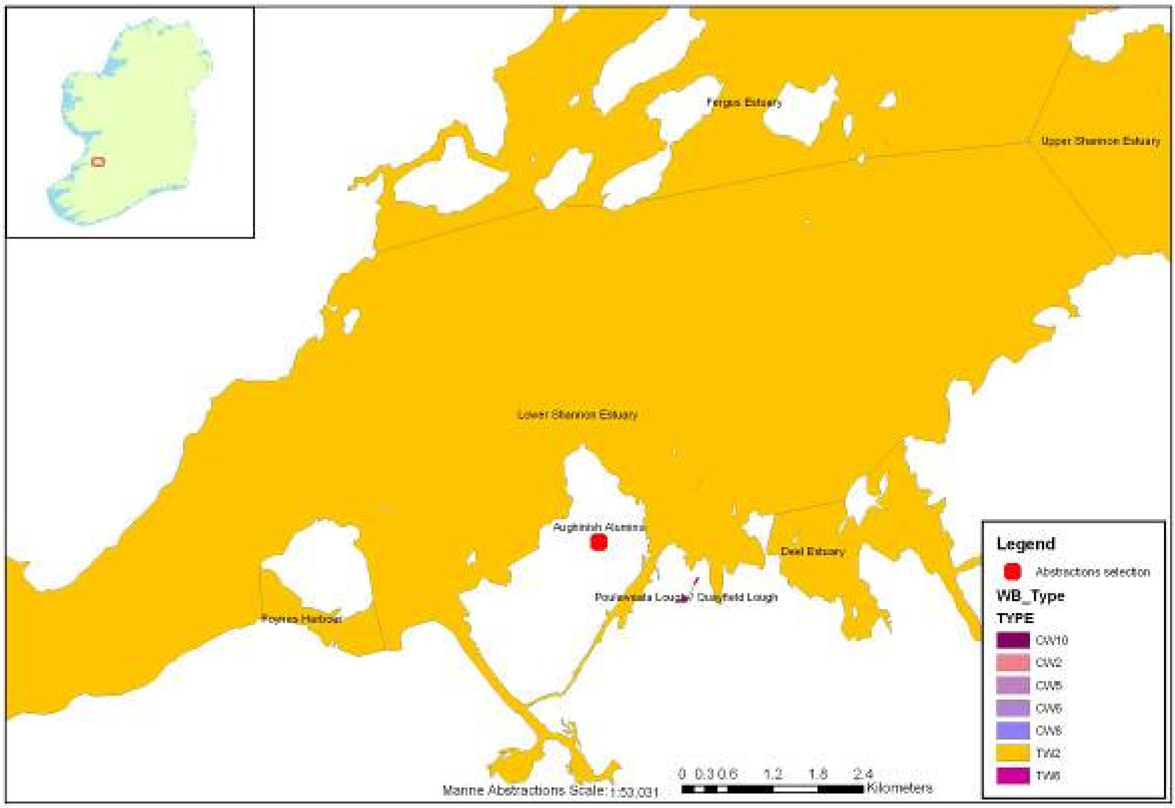


Figure 3.12 Marine Abstractions records

Table 3.9: Data Resources - Summary of the information assessed for Abstractions

File Name/Type	Data Description	Geographic location of dataset	Sourced from	Data Owner / Originator
SWRBD Surface abstractions.shp	Point data of surface water abstractions in the SWRBD area. No marine or estuarine abstractions recorded.	SWRBD	SWRBD	SWRBD
WFD schema.dbf	Abstractions table from geodatabase	RoI	EPA	EPA
WFD schema.dbf	IPPC data for coastal facilities	RoI	EPA	EPA
Abstraction surface point.shp	WRBD marine pressure layers, morphology. Four points recorded for the same facility in the Shannon	WRBD	WRBD	WRBD

3.3 Morphology

3.3.1 Data Resources

In order to provide a concise general description of the water body morphology, a number of sources were identified and assessed. These included internet searches for the area and academic texts and the information was recorded on the water body summary sheets to provide and enhance the description of the whole water body. The information was not detailed or consistent enough to allow retyping of the water bodies. This may need to be re-assessed when further information is available for the next RBMP (See Chapter 4 and 9).

River Basin District Initial Risk Assessment

Water bodies were assigned types for the initial risk assessment and this information assisted with the interpretation of the morphological conditions. The initial typology assessment (Sniffer, 2006, WFD-07) and the baseline datasets were also consulted. The information from the report classified the water bodies according to their morphology type. The GIS information also has some generic coverage of sediment types and exposure; however the coverage and resolution of the data was course and incomplete.

Other sources

Generic water body descriptions were compiled from a number of sources, such as SAC site synopsis, GSI descriptions and academic and other information from EIS, survey data (including BioMAR), local government information and internet searches. This was used to provide a generic description of the water body and compared to the morphological attributes used in the Morphological Description (See Chapter 4). Insufficient information was collated to reliably question the Article 5 characterisation. However no significant conflicting information was found. This information and the references were recorded in the water body summary sheets.

3.4 Ecology

In order to provide a concise general description of the water body a number of sources were identified, including internet searches for the area and academic texts. These were recorded on the water body summary sheets and are summarised in Table 3.10.

3.4.1 Data Resources

Table 3.10 lists the data sources, which, supported by academic and public literature research, were used to provide a generalised ecological overview of each water body summary sheet.

River Basin District Initial Risk Assessment

Water bodies were assigned types for the initial risk assessment and this information assisted with the interpretation of the ecology information. The initial typology assessment (Sniffer WFD-07) was also consulted. Protected areas were coded and mapped as part of the initial risk assessment.

National Parks and Wildlife Services

Protected area updates were downloaded from the website and used to ensure complete coverage of SACs, Special Protected Areas, (SPAs) and Natural Heritage Areas (NHAs). As of the 2008 protected areas update from the NPWS, the NHAs are statutory NHAs and are reported as such in the summary sheets (personal communication NPWS 07/04/08)

The NPWS website (www.npws.ie) was consulted to review the site synopses for protected areas identified within water bodies.

In 2007 some of the marine SAC sites were biotope mapped under contract from the NPWS. It is planned to continue this work for other coastal and marine SACs in the coming years (See Chapter 4). The initial results of the 2007 surveys for four sites were provided in ArcGIS by Marine Institute and permission given from the NPWS to use the data which included detailed habitat maps of the protected areas surveyed (Figure 3.13). Where these sites occurred in water bodies already assessed, the biotope information was used to inform the ecological description. The information in these surveys is significantly more detailed than that available in most areas and would allow in depth evaluation of future developments.

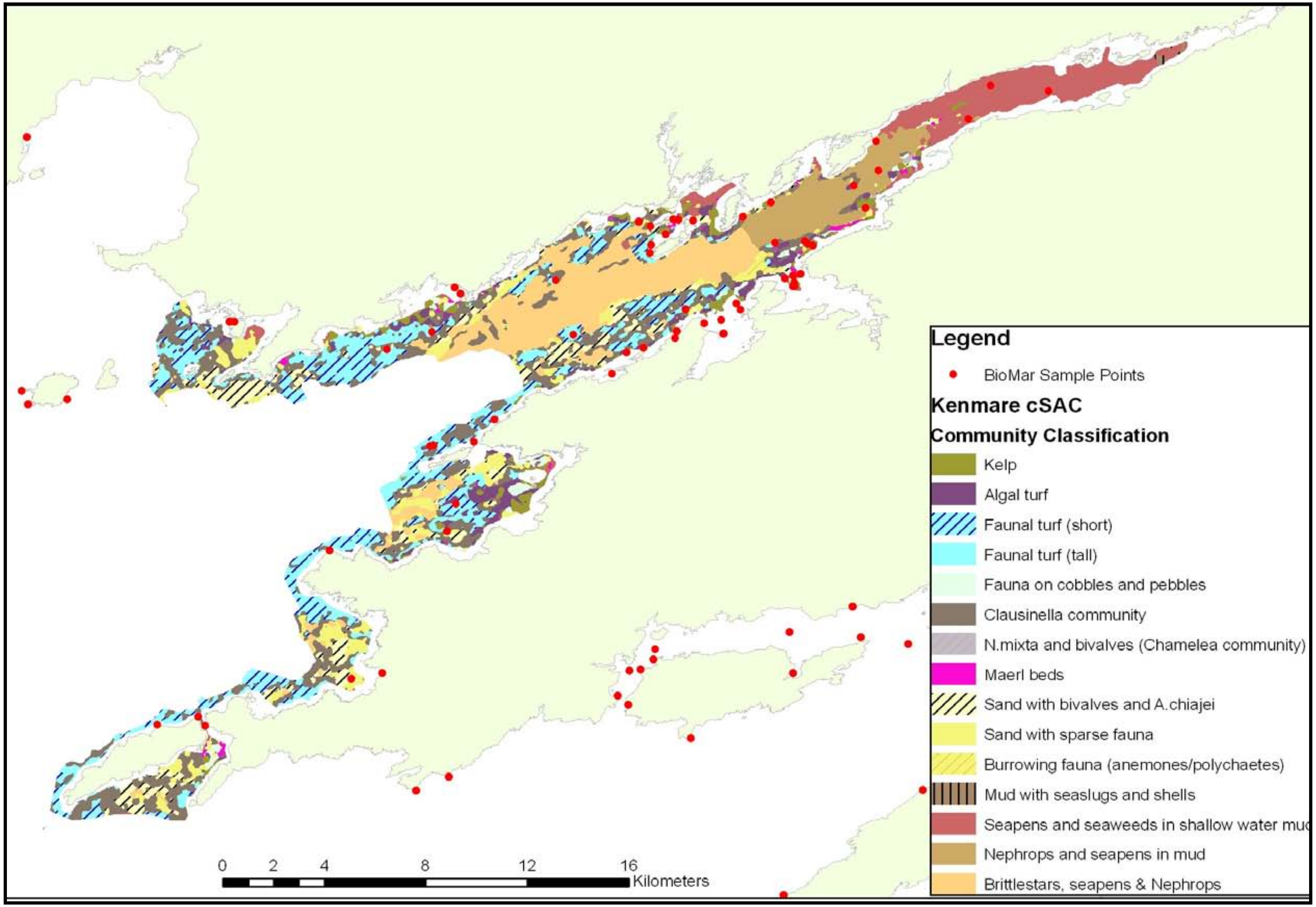


Figure 3.13: BioMAR records and NPWS habitat mapping for Kenmare Candidate Special Area of Conservation (cSAC)

BioMAR

A copy of the BioMAR database was provided by the NPWS and an x,y event layer of surveys was created. BioMAR was a part European funded survey of littoral and sublittoral coastal habitats, which ran from 1992 to 1996. The results of the recorded biotopes and descriptions were included in the water body summary sheet ecology descriptions. In addition, the database was compared with the JNCC Marine recorder data (2007) to ensure complete survey record coverage, and to capture any survey data points from 1996 to 2000. Within the water body summary sheets the information from each survey station or transect is listed. Where there are multiple points across a bay, a summary of the survey points is provided. Where recorded, a biotope code is provided as referenced in the original survey, and a description of the sample site is provided.

UK Joint Nature Conservation Committee (JNCC) Marine Recorder

Permission was given from the JNCC to compare the BioMAR results to the Marine Recorder database to ensure complete coverage (biotope_merge.shp).

Table 3.10: Summary of the information assessed for Ecology

File Name / Type	Data Description	Geographic location	Sourced from	Data Owner / Originator
Biomarsites.shp	BioMAR survey sites from database	RoI	NPWS	NPWS
Biotope_merge.shp	Point file of survey sites extracted from Marine recorder 2000 database, this was a limited copy with some sources not included due to data ownership and permissions	RoI and UK	JNCC	JNCC
Sac_merge	Merged national coverage of county datasets from www.environ,ie, downloaded and updated as of 15/02/08	RoI	NPWS	NPWS
Spa_merge	Merged national coverage of county datasets from www.environ,ie, downloaded and updated as of 15/02/08	RoI	NPWS	NPWS
Nha_merge	Merged national coverage of county datasets from www.environ,ie, downloaded and updated as of 15/02/08	RoI	NPWS	NPWS
Ramsar	RAMSAR site file with links to site synopsis from RAMSAR website	RoI	Ramsar.ie	NPWS
Protected Areas	PA coded polgons of protected areas	RoI	WFD schema	EPA
Roaringwater bay	cSAC survey data and provisional habitat map from 2007 surveys	cSAC	NPWS	NPWS
Kilkiernan	cSAC survey data and provisional habitat map from 2007 surveys	cSAC	NPWS	NPWS
Kenmare	cSAC survey data and provisional habitat map from 2007 surveys	cSAC	NPWS	NPWS
Clew Bay	cSAC survey data and provisional habitat map from 2007 surveys	cSAC	NPWS	NPWS

In addition to these resources, the EIS from the ENFO were reviewed for any coastal developments. Those with relevant marine or coastal developments were reviewed for biological information, both general descriptions and species data from baseline surveys. Where relevant this information was also summarised in the general ecological description.

3.4.2 Methodology for Assessing Ecology

The following method was used to assess Ecology:

a. From the information available a short summary of the ecology and biotopes recorded within a water body was included in the water body summary sheets, accompanied by a map of the water body, the protected areas and any biotope records that were mapped.

b. A link is provided in the Water Body Summary Sheets to the ***MarLIN*** website which provides information of the biotopes and the sensitivity to physical and chemical modifications. Unfortunately, there was insufficient biological information to carry out a full appraisal of the water body's ecological sensitivity to physical changes as outlined in Chapter. However, the links to the ***MarLIN*** sensitivity information is included with the summary sheets.

3.5 Pressure Footprints

Once all pressures footprints were defined where required, each feature was assigned to its corresponding water body using a combination of automatic and manual methods. The assessment of pressures within TraC-MImAS also requires that the footprint of each pressure is estimated for the intertidal and subtidal zones of each water body. The proportion of each footprint was assigned to a tidal zone using the intertidal zone shapefile created via combination of automatic and manual methods.

A shapefile containing records for all 309 water bodies was compiled with the results of the initial risk assessments and pressure footprints calculated by the above methods. Each footprint is expressed in metres and kilometres. This information is then used within the TraC-MImAS to assist in the further characterisation of risk to TraC water bodies (refer to Chapter 5).

3.6 Delivery and dissemination

Due to the end user issues, there are difficulties with the dissemination of the data gathered for this project. The pressure layers created for the project through the methods outlined above will be delivered to Cork County Council with this report, under the terms of agreement with the various data providers. These layers will include metadata outlining all source data used in the development of the layers, and acknowledges the data providers and their rights over the information. The SWRBD project team will add these layers to the EPA WFD Schema, assuming no objection from the data providers, to make this information available for national appraisal. The source data will be provided to the Cork County Council only, and archived pending future data agreements with the source organisations.

The data agreements between the various organisations and Cork County Council were defined by either the data provider, or under the data agreement prepared by the SWRBD project team. This agreement and the terms of use from others were to allow the pressures layers to be disseminated to the organisations and councils who are involved in implementing the WFD. However, in all cases the rights are reserved by the data provider. The future handover of the data from Cork County Council to a final responsible body will require permission from the data providers. It is hoped that this end user will be a governmental department or a government agent/agency. This would mean intergovernmental data agreements would be able to be used to access more comprehensive baseline data.

The relevant licence restrictions on the incoming information have been logged with the file reference and a copy is inserted into each folder.

All data generated has been provided with the following disclaimer in the metadata:

No data may be re-produced or transmitted in any form or stored in any retrieval system of any nature, without the written permission of SWRBD Project Office, as Copyright Holder, except as agreed for use on this specific project. All rights reserved by original data provider.

3.7 Recommendations for Further Data Requirements

The data that was able to be collected for the Marine Morphology task was severely limited by the departmental re-organisation of marine services within the government. This resulted in confusion in data ownership that prevented data access for this project as well as difficulties in defining the end user for the data tool.

Several sub projects designed to provide government data for applications such as this one also have had difficulties due to these changes; most notably the COZAS programme, which was to provide marine licensing GIS data from the former DCMNR. As a result the records, and particular areas of activities such as recent dredging, had to be researched in detail, and in some cases estimated from the limited available information. Hopefully this programme will be reinstated in the near future, along with the associated programmes such as the Integrated Fisheries Information System (IFIS) that was to provide centralised GIS fisheries and aquaculture information.

Though a centralised series of government databases for the marine environment is unlikely, especially with the dissolution of a designated government department, better data sharing and interoperability between departments is needed.

This project has collated a significant amount of data, much of which is relevant to future assessment of the water bodies, which will be provided to Cork County Council on project completion. In addition, work has been carried out to generate and digitise data from a number of sources, most notably the orthophotography. A responsible body or end user will need to take ownership of this work in order to allow dissemination to the various RBDs or councils to enable them to assess proposals against morphology and GES, and to ensure the data is updated.

Unfortunately, a full national coastal set of geographically referenced orthophotography was not available for this study. Ideally, each County Council should ensure that they have secured permission and the data from the OSi, and this should be a priority for future coastal appraisal and planning. This information, when used with the former DCMNR oblique coastal images allows the verification and interpretation of coastal features and data. At a local level, site visits or local knowledge verification may be possible through the relevant councils, though for this national study, such site visits are impractical.

The water bodies represent a national reference dataset of rivers, lakes, transitional and marine waters around Ireland. A national coastline is therefore the inverse of these areas, and an ERSI shape file was created of the internal area of the coastal and transitional water bodies that represented this area. However, during the course of this project, a national and low water mark were unable to be obtained – as highlighted above. As this represents a boundary of governmental and local authority department responsibilities, it is essential that this dataset be developed and provided to the various bodies involved in implementing the WFD.

3.7.1 Baseline Data

There are a number of baseline elements that are essential to the evaluation of water bodies. These elements were not available for the majority of the RoI, but are available for other European marine areas. However there are a series of programmes currently underway that will hopefully fill this knowledge gap (see Chapter 4).

The resolution of many of the baseline datasets, such as the intertidal and water body shapefiles, were generally insufficient for the study. Small spatial errors had to be corrected wherever possible to ensure accuracy of the overall appraisal. However, in the cases of the water bodies, these were set nationally and had small boundary errors with orthophotos and the Irish Coastline.

From the Interim Data Review much more data was thought to be available than could be accessed and collated for this study. As a result, much of the pressure information had to be created. The lack of vectorised Ordnance Survey, and coverage of historic maps and orthophotographs on a national basis, impacted the ability to generate information on these pressures.

For future decision making, it is essential that this baseline information is made available to national and local government. Without this baseline information, the assessment WFD issues in the marine environment will be extremely difficult.

3.7.2 Morphological Data

The morphological or eco-morphological parameters to assess the type and conditions of the water body are predominantly sediment type, depth, exposure and salinity which are all associated with the physical characteristics, flow and tidal regimes of the estuary or water body. This physical environment is the main factor affecting the ecology, and is often used as the initial definition of a biotope. For example the EUNIS classifications system initially uses the physical hierarchy, then biological, to classify marine communities. Comparison between ecologically surveyed parameters and eco-geomorphological attributes is outlined in Chapters 4 and 9.

In inshore waters, the data for these elements is sparse. There is no vectorised bathymetric data available from the IHO (International Hydrographic Office) or Admiralty Charts, though the former DCMNR did have a raster version of the Skipper Series from which this information could be digitised. However the status and licence for this data is currently unavailable due to departmental changes and would also be an immense undertaking. Even the 1997 GEBCO charts which give point depth data for much of world, and versions that have been merged with existing data are now largely unavailable as they are no longer being distributed as the data is dated and the INFOMAR project will eventually replace this information.

Many of these near-shore parameters are being surveyed and evaluated for coastal erosion programmes. The European EUROSION data was used to evaluate areas for this project, but much of the data was not sufficiently detailed in Ireland.

Sediment maps are not available for much of the west coast. Sediment type was evaluated from various point sources. The GSI does have Sea Bed Sediment maps (SBS) but only for offshore areas or not in sufficient scale for inshore or water body evaluation. The future programmes such as INFOMAR and the protected area mapping from the NPWS will eventually provide this information for the next series of RBMPs.

Flow and salinity data for water body characterisation relied on the cross referencing of the coastal typology with the available data on ecology and tidal information from the Marine Institute and the Marine Models database. The typology for MImAS is consistent with the methods used to type the water bodies in the SNIFFER (WFD07) report, and these descriptions were checked and used to inform the impact evaluation. This information is not sufficiently detailed to reassess. However, there is monitoring planned to assess these factors in the future, and changes to water body type, either redefined by the monitoring results or as a result of impact, can be updated (see Chapter 4).

3.7.3 Pressures

Much of the data for pressures was developed or digitised for orthophotography and oblique photographic images. This is a laborious and time consuming exercise.

Much of the data on coastal structure and historical changes is available in hard copy in the DCENR Coastal Engineering division, and much of it is, or will be, digital data to support the flood risk projects currently underway. It is assumed that these drawings and records are catalogued and a valuable interim measure would be to link this catalogue to a spatial or even water body reference to allow querying of this information for the assessment of future developments. Again the release and ownership of this data was hampered by the lack of a government representative to receive the data stored and generated by this project. This is an important issue that must be resolved prior to the RBMPs being enacted.

Databases on foreshore licensing, marine dredging, dumping at sea and aquaculture / fisheries are still in their relative infancy in Ireland. The information is available, but generally in insufficient detail for mapping at water body scale. There were a series of initiatives through the former DCMNR to integrate and centralise this data, with GIS as a significant element. However, these programmes have not yet provided the mapping data required for this study, and as a result, the data was generated or surrogate information used for this study.

A number of decisions were made during the course of this study that may require further appraisal by a suitable regulator. For example, no ‘time limit’ was given to land claim - it was identified from changes between historic maps and the most up-to-date orthophotography available. However, in many cases, some land claim had already occurred prior to the historic maps. Dublin Bay, for example, has been altered for over 700 years as a site for ports and harbours, and there is no limit within MImAS as to the point from which an initial water body condition should be assessed.

The WFD schema, and ongoing work integrating the results of all the PoMS studies, provides an active national and local government template for potential data sharing. The nature of the WFD has allowed intergovernmental sharing of data, identification of metadata on existing information, and future planning for web-enabled mapping information to be available to decision makers and unrestricted information to be passed into the public domain.

3.8 Conclusions

This study has examined the possible sources of data for marine morphology. Though hampered by the lack of an appropriate end user, and unable to benefit from government interdepartmental data sharing that would have allowed greater access to some key datasets, the relevant pressures for marine morphology have been developed by analysing available information and digitising extents from aerial and oblique photography. The extent and demands of this data generation have been much greater that perceived at the project outset compounded by the fact that a series of supporting programmes to collate this information nationally for government did not occur for the marine environment.

Despite this, a series of national marine morphology pressures have been created and assessed as part of this study to enable impact assessment of these and future pressures on Irelands TraC water bodies. The data was developed to the best scale and detail possible given the limitations described above, to provide a comprehensive and consistent dataset for Ireland to use in the impact assessment.

From the best information available for this study the pressures have been compiled and assessed and provided with full metadata. It is hoped that these derived layers can be made available through Cork County Council and EPA WFD Schema to the relevant national and local authorities. However, a suitable end user to take ownership for the collected information and generated data and its continued updating was not able to be identified during the course of this study.

4 REVIEW OF EXISTING MONITORING SYSTEMS

4.1 Introduction 2
4.2 Review of Organisations Involved 3
4.3 Review Summary of Existing Marine Monitoring 7
4.3.1 Introduction 7
4.3.2 Pre-WFD Monitoring Programmes 8
4.3.3 Variable Measured for Marine Water Samples 13
4.3.4 Environmental Impact Assessments / Investigations 16
4.3.5 Conservation Monitoring 16
4.3.6 Post-WFD Monitoring Programmes 17
4.4 Water Framework Directive Monitoring Programme for TraC Waters ... 19
4.5 Conclusions 25

This chapter summarises the findings of a review of existing European and national monitoring systems with the aim to determine if the programmes in place are of benefit to the assessment of morphological conditions within TraC waters.

There are two main requirements for marine morphology data under the WFD; to determine the ecological status of a water body, and to detect changes that may affect this status. Any relationship between existing monitoring programmes and these requirements is outlined.

Recommendations for the design of the monitoring programme in relation to morphology are outlined in Chapter 9.

4.1 Introduction

The Water Framework Directive (WFD) requires the monitoring and assessment of the ecological status of all waters within it's geographic boundaries. Article 8 (1) of the directive states '***Member States shall ensure the establishment of programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of water status within each river basin district'***. In accordance with Ireland's regulations implementing the WFD (S.I. No.722 of 2003); the Environmental Protection Agency (EPA) have prepared a programme of monitoring of water status to achieve the requirements of Article 8 (and Article 7 which specifically relates to the abstraction of drinking water) of the WFD, to be operational by December 2006. Also, the EPA has specified the authority by which the monitoring is to be carried out. Those authorities assigned monitoring tasks in the TraC component of the WFD monitoring programme are the EPA, the Office of Public Works and the Marine Institute.

For high ecological status to be achieved, the WFD requires that there are no more than very minor human alterations to the hydromorphological quality element. To determine this, existing baseline conditions and / or absence of pressures should be demonstrated. For all other status classes, conditions should be '***consistent with the achievement of the values specified for the biological quality elements'*** (WFD, Annex V).

Formal hydromorphology classification tools have yet to be developed for use in Ireland. As noted in Section 5.4.2 of Chapter 5, work aimed at developing hydromorphological reference conditions and a draft classification scheme for TraC waters has commenced in the UK (EA and SNIFFER). However, this has not resulted in formal classification tools, but has emphasised the importance of the biological classification scheme incorporating metrics that were sensitive to hydromorphological changes. Few of the biological classification tools developed for use in Ireland are relevant to morphology; these are discussed further in Section 4.3.6.

Marine Monitoring and Marine Morphology

Monitoring of morphology is a difficult process for which extensive baseline information is required. This may include detailed bathymetry and flow information, or hydrodynamic models. A baseline of morphological condition is an essential element in providing a point of temporal reference from which change can be assessed.

However, in many cases adequate baseline information is not available. This chapter outlines the ongoing programmes that may provide this information in the future and reviews those programmes that may be enhanced to include morphological monitoring.

Though responses to man-made developments or extreme events can be rapid, in general, natural morphological changes occur over long periods of time; therefore time series data is essential to detect changes. A variety of existing marine monitoring occurs in Europe, though there are few national programmes looking specifically at morphology. As a result, indicators or surrogates for morphological change monitoring may need to be identified from the existing programmes, until such time as the WFD monitoring can provide further information.

Chapter 9 follows on from this review of existing systems to recommend surrogate information from existing sources which can be used in the meantime to assess change.

The following sections give an overview of the existing Irish and European marine monitoring systems. They also identify the existing time series data that may be available to represent baseline conditions and assist in monitoring future changes to morphology.

4.2 Review of Organisations Involved

The Department of Environment, Heritage and Local Government (DEHLG)

The Minister for the Environment has the overall responsibility for the development and implementation of environmental policy in Ireland. The Department of the Environment, Heritage and Local Government (DEHLG) formulates the relevant legislative framework to maintain satisfactory regulatory and monitoring systems for environmental protection and to secure the provision of infrastructural services necessary for both environmental and developmental purposes. The responsibilities of the Department regarding environmental information are the result of policy needs, statutory requirements and international obligations.

Environmental Protection Agency

The EPA operates under the aegis of the DEHLG. It is an independent agency that was set up according to the Environmental Protection Agency Act of 1992. Its wide range of functions includes an overall co-ordination and supervisory role relating to environmental monitoring, including the monitoring of surface waters. In particular, the Agency is required to prepare a national monitoring programme and to identify the organisations to undertake its implementation. The EPA is one of the competent authorities under the Water Framework Directive.

The existing estuarine and coastal monitoring programme, which is discussed further in Section 4.3 below, should be replaced by the WFD Monitoring Programme (Section 4.4) which became operational on the 22 December 2006. The new WFD programme for transitional and coastal waters is to be undertaken by the Environmental Protection Agency in collaboration with the Marine Institute, Central Fisheries Board and National Parks and Wildlife Service (NPWS), with those tasks of relevance to hydromorphology assigned to the EPA, Marine Institute and the OPW. In the new programme a total of 117 water bodies consisting of 82 transitional and 35 coastal will be monitored. The existing coastal and marine surface water monitoring sites for Ireland are mapped by the EPA as shown in Figure 4.1 below.

As a result of funding issues, elements of the monitoring programme to be undertaken by the Marine Institute have not yet commenced.

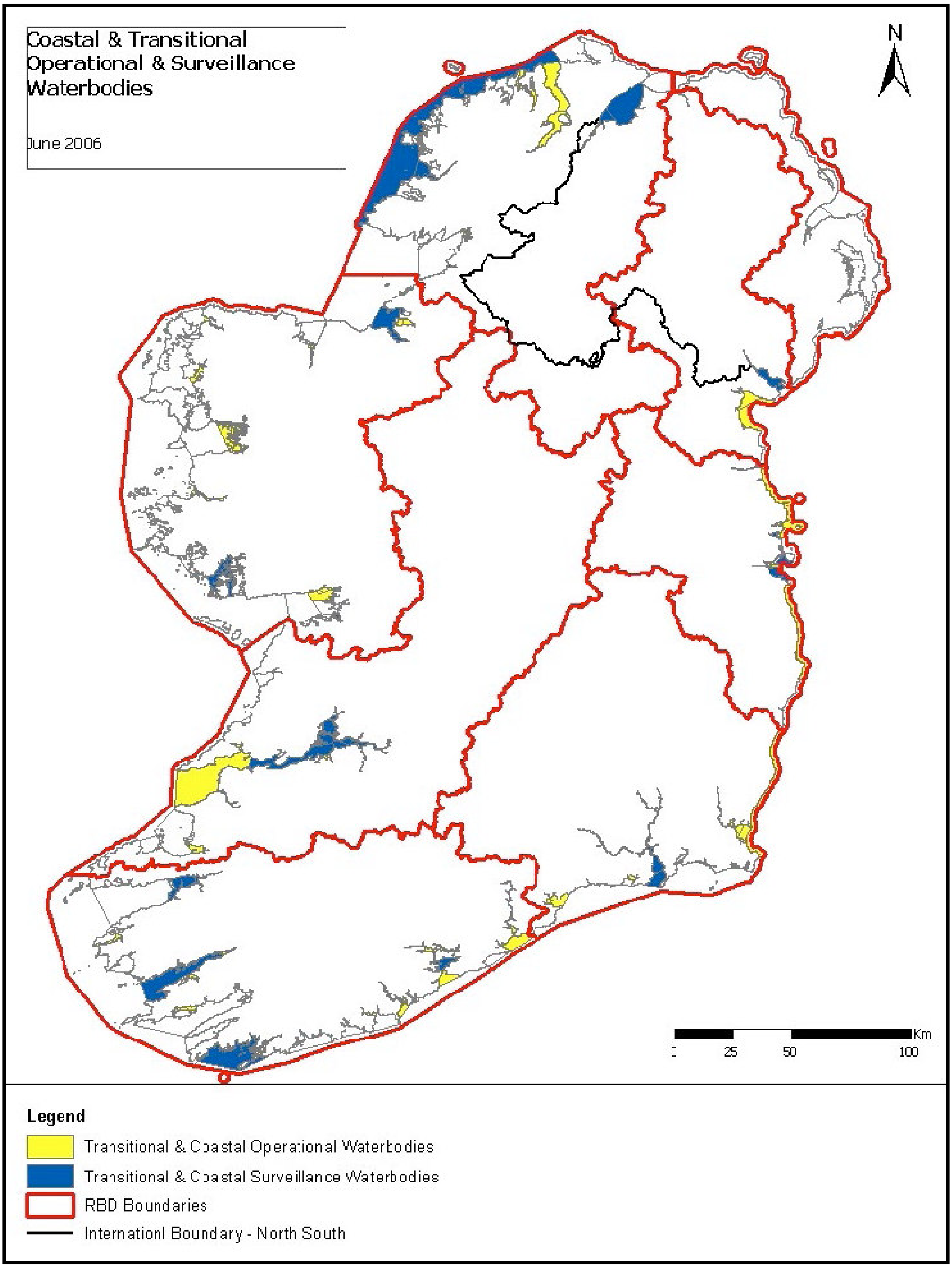


Figure 4.1: Coastal and Transitional Marine Operational and Surveillance Monitoring (Source: EPA, 2006 WFD Monitoring Programme)

National Parks and Wildlife Service

The NPWS, part of the DEHLG, manages the Irish State's nature conservation responsibilities under National and European law.

A particular responsibility of NPWS is the designation, monitoring and protection of Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Natural Heritage Areas (NHAs). Consultation with interested parties is an integral element of the designation process.

For the purpose of the WFD monitoring programme and of relevance to TraC morphology, the NPWS are responsible for the monitoring of coastal angiosperms.

The former Department of Communications, Marine and Natural Resources (DCMNR) and the Marine Institute

Prior to Irelands reallocation of Departmental responsibilities after the 2007 general elections, the DCMNR (formally the Department of Marine) implemented marine monitoring programmes mainly through the work of its Fisheries Research Centre and this role was devolved to the Marine Institute, established under the 1991 Marine Institute Act.

The monitoring programmes have been carried out with the following objectives:

- ensuring the quality of fish for human consumption;
- identifying sources of pollution;
- determining temporal trends and spatial distribution of contaminants in offshore, coastal and estuarine environments.
- meet European and International (OSPAR, ICES etc) reporting objectives

An important aim of the programmes is to comply with various international agreements. Quality assurance activities include participation in the EU-funded QUASIMEME quality control programme. The Marine Institute also compiles a number of national data programmes for Oceanographic data, such as the National Tidal Gauge Network.

The Marine Institute, currently under the aegis of DAFF, proposed a comprehensive monitoring programme for the marine elements of the WFD in 2006/2007(MI, in press). The programme identified the need for, but did not include the specification for monitoring of morphological elements of the WFD. However, the information collected can be interpreted for morphological monitoring as outlined in Section 4.3.3

below. Most importantly a morphological baseline is identified as being collected under the GSI (Geological Survey Ireland) and Marine Institutes' Integrated mapping for the sustainable development of Ireland's marine resource (INFOMAR) programme, which is also detailed below (Section 4.3.6).

Department of Agriculture, Fisheries and Food (DAFF)

As of 2007, the DAFF has been assigned a number of the responsibilities of the former DCMNR, with other responsibilities being managed by the DEHLG, the Department of Communications, Energy and Natural Resources (DCENR) and the Department of Transport (DoT).

4.3 Review Summary of Existing Marine Monitoring

4.3.1 Introduction

A review of existing monitoring programmes has concluded that morphological quality elements are currently poorly represented by Irish systems. However, information relating to these elements may be included in the data associated with the samples taken for other means. For example, ecological/conservation monitoring may record the location, depth and granulometry / substrate of a site, and general descriptions of the physiotope (physical habitat). This information can be used to help determine a baseline and detect changes in morphology, as it can provide time series data.

The data review undertaken by this study and reported in Chapter 3 found that Ireland has little morphological baseline information from which to monitor change, and although hydrographic charts and information is available, electronically there is poor inshore information and no vectorised Hydrographic Office data. At present the data collected by previous coastal monitoring programmes is not held within a central repository, however, as monitoring is the responsibility of few select authorities, the collation of this information is feasible.

As part of the National Monitoring Programme the NS-Share project team developed a Marine Monitoring Database collating information for existing monitoring programmes within the one nautical mile limit of TraC water bodies. Where possible, data, which was compiled on a water body basis, consisted of the following information:

- Water body designation
- Risk assessment results
- Existing monitoring programmes
- Whether a point is a once-off dataset or repeat
- Relationship of monitoring points to other water bodies
- Pressures which exist on the water bodies

This database provides a very useful framework for the collation of TraC monitoring information, and would be of benefit if updated and maintained following the completion of national PoMS studies and WFD monitoring programme.

4.3.2 Pre-WFD Monitoring Programmes

In the EEA area the Oslo and Paris Commissions (OSPARCOM) and North Sea Task Force are responsible for the overall coordination of monitoring in the North-east Atlantic and the North Sea, while the Helsinki Commission (HELCOM) is in charge of the overall coordination of monitoring of the Baltic Sea, the monitoring of the Mediterranean being coordinated by the UNEP/MEDPOL programme.

The countries bordering these marine areas participate in the international monitoring programmes and the monitoring activities are incorporated into the national marine monitoring programmes. The national marine monitoring programmes are, however, generally more comprehensive including more sampling sites, especially in coastal areas, and measurement of more variables. The general purpose of national marine monitoring programmes is to assess the environmental state of the nationally important marine areas, and the national programmes are thus aimed at giving a nation-wide overview of marine environmental quality status.

The EEA 1996, 'Surface Water Quality Monitoring' assessed national marine monitoring programmes and made a comparison of similarities and differences between the different existing marine monitoring activities. In total, information on approximately 38 national marine monitoring programmes from ten countries has been assessed by the EEA. Table 4.1 outlines those programmes reported for Ireland and the UK. The OPSAR and INTERREG SIAM (Synergies in Assessment and Monitoring) programme is currently reviewing existing programmes, looking at synergies between programmes and European Directive objectives.

Table 4.1: National marine monitoring programmes in Ireland & the UK (derived using Surface Water Quality Monitoring, EEA (1996))

Country	Name	Variables W: Water; B: Biota; S: Sediment	Start year and sampling frequency (SF)	Geographical coverage
Ireland	General Quality of Estuarine and Coastal Receiving Waters	W: C&P WQ variables	Since 1992 SF: 1-?/yr	Significant estuarine and coastal areas
	Toxic contaminant levels in the estuarine and coastal environment	W: C&P WQ variables S: metals, OMP B: metals, OMP	Since 1993 SF: 1/5-6 yr	Nation-wide. Significant estuarine and coastal areas
	Radioactivity monitoring of the Irish marine environment	Radioactivity in water, sediment and biota	Since the early 1970s SF: 2-4/yr	Nation-wide particularly areas affected by Sellafield
	Bathing waters	W: C&P WQ variables and microbiological indicators	Since 1979 SF: 1/1-2 week in summer	Nation-wide. 92 important marine bathing areas
	Bacteriological quality of shellfish waters	COLIFAEC in water and shellfish		
	Monitoring of human food sources	W: C&P WQ variables B: metals, OMP	Since 1992 SF: 1/yr	18 shellfish growing areas Fish landings from 5 important fishing ports
UK	UK National Marine Monitoring Plan	W: C&P WQ variables S: metals, OMP	Data from at least 1988 SF: water 1-4/yr biota 1-2/yr sediment 1/yr	Approx. 100 sites in the upper, middle and lower reaches of estuaries, inshore and offshore coastal sites around the UK
	Marine Algae Monitoring Programme	Marine algae	Since 1991 Weekly from May to September	640 identified and non-identified bathing waters
	Monitoring of Bathing Waters	Bacteria and a few physical and organic pollution determinands.	SF: 20 samples a year during the bathing season.	460 bathing waters in Scotland, Northern Ireland and England & Wales.
	Water Quality of Shellfish Waters	Heavy metals, organic micropollutants.	SF: 2-12/year depending on variable type.	29 shellfish waters.

KEY:

Biology: PHYTPL - Phytoplankton; ZOOPL – Zooplankton; ZOOBEN – Zoobenthos; MAPHYT - macrophytes

WQ - Water quality; C&P - Chemical and Physical

Prior to the WFD monitoring programme, those reported as operational in Ireland's marine waters are summarised in Table 4.2 below. Subject to the confirmation of the WFD marine monitoring these programme are considered active.

This national marine monitoring programme is a combination of the EPA and Marine Institute programmes. The EPA programme aimed at providing a general assessment of the quality of Irish estuarine and coastal waters, while the Marine Institute programmes concentrated on the Irish Sea. The programme for coastal and marine areas was split into 5 individual programmes:

- M1 focuses on the impact of organic waste and nutrients.
- M2 focuses on toxic contaminants (heavy metals and organic micropollutants) in the Irish estuarine and coastal environments (this programme will sample a mix of water column concentrations and sediments).
- M3 concerns monitoring of radioactivity in the Irish marine environment from water sampling and sediments (material for dumping at sea and dredging is also monitored under the existing legislation).
- M4 focuses on bathing water quality, predominantly for faecal coliform presence,
- M5 and M6 assess the quality of seafood used for human consumption.

In addition to the programmes noted above marine biological monitoring is undertaken by the Marine Institute in a number of separate programmes of varying intensity and duration.

Some of these programmes have, and will be replaced by the WFD monitoring programme. Some associated with the Marine Institute (and DAFF) are proposed within the Marine Institute's monitoring proposal issued to the DEHLG.

The results of these programmes are reported to Europe in a standard cross country format and will form an updated version of the 'Status of the Seas' reports produced by the EEA under the EU. The common WFD format should allow cross comparison and the identification of any larger scale trends that may require strategic attention.

Table 4.2: Irish national surface water monitoring programmes (extract from EPA, 1996)

No.	Name	Responsible institution	Variables	Period of operation & Frequency (SF)	Geographical coverage	Data & national reporting
M1	General Quality of Estuarine and Coastal Receiving Waters Including Nutrients.	MI, EPA, DAFF/DEHLG & Local authorities	Water: Physical and chemical variables	Since 1992. 1 winter survey and a number of surveys in summer	Nation-wide. Significant estuaries & coastal areas and the Western Irish Sea	Reporting: 1/4 yr by EPA, DAFF/DEHLG & local Authorities
M2	Metals and organic micropollutants in the Estuarine and Coastal Environment.	MI, EPA, DAFF/DEHLG & Local authorities,	Water: organic micropollutants Sediment & biota: heavy metals & organic micropollutants	Since 1993 One major estuary per year in a 5-6 year cycle. Trend monitoring of metals in mussels	Nation-wide	Reporting by MI to the OSPAR Joint Monitoring Group (JMG)
M3	Radioactivity Monitoring of the Irish Marine Environment.	Radiological Protection Institute of Ireland (RPII)	Radionucleides in water, sediment, & biota	Since the early 1970s. SF: 2-4/yr.	Nation-wide. Greatest density of sites where the impact of the Sellafield facility is greatest.	Reporting: 1/2yr by RPII
M4	Environmental Quality of Amenity and Recreation Areas, in particular, Bathing Waters	DEHLG Local Authorities	Water: Physical, chemical, & microbiological variables	Since 1979 SF: 1/1-2 week from mid-May to ultimo August	Nation-wide. A total of 92 important marine bathing areas	National reporting annually by DEHLFG
M5	Bacteriological Quality of Shellfish Waters.	DAFF/DEHLG (EPA)	Faecal coli in water and shellfish.	Since 1981 SF: 2 weeks intervals throughout the year	Mainly W and SW coast. 200 locations in 50 coastal inlets	DAFF/DEHLG
M6	Monitoring of Human Food Sources.	DAFF/DEHLG/MI, (EPA)	Water: Physical variables Shellfish: metals & organic micropollutants Fish: HG	Since 1992 SF: Annually	Nation-wide. 18 shellfish growing waters and 5 important fishing ports	MI, JMG

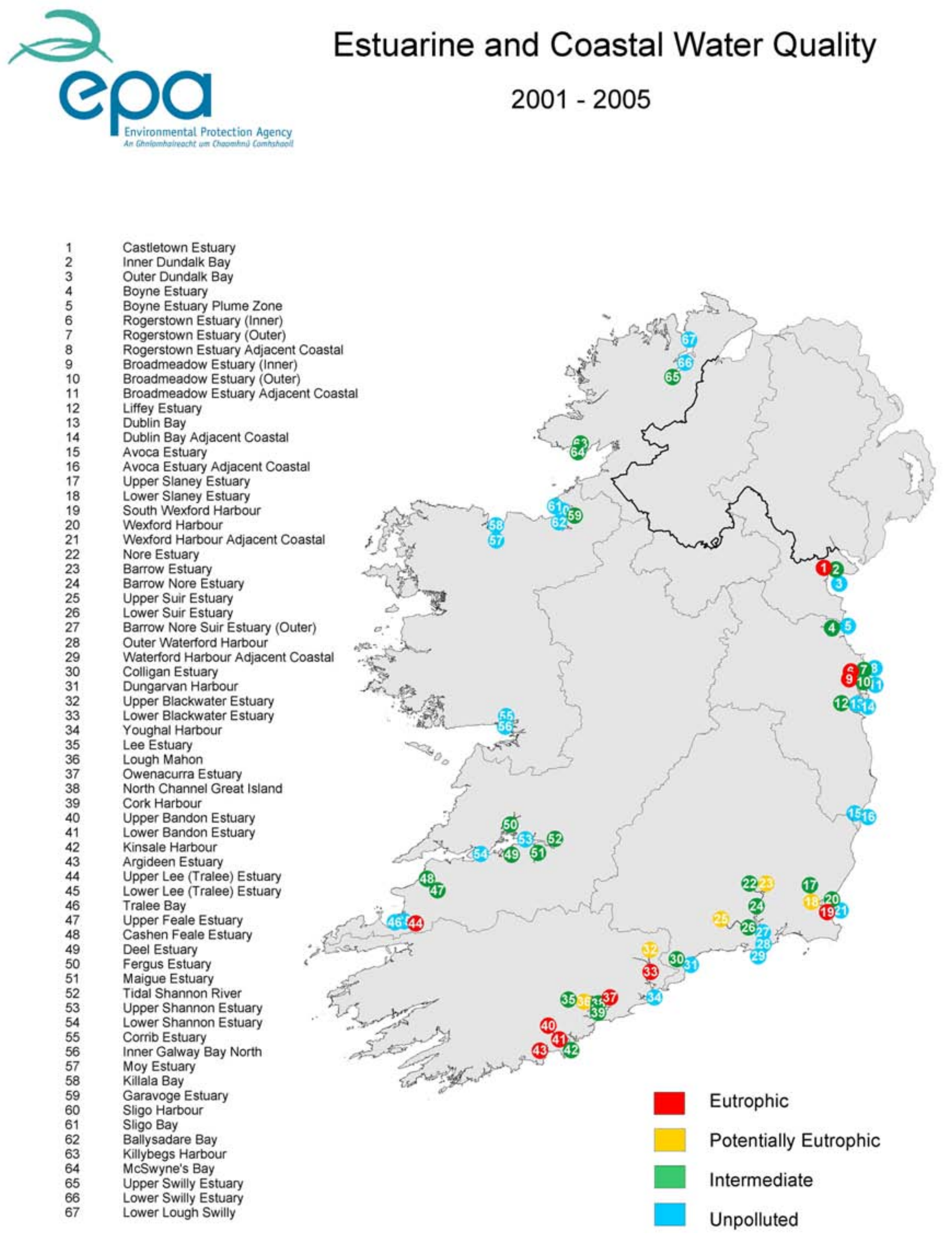


Figure 4.2: Location and results of existing water quality programmes pre-WFD (Source: EPA, 2006; Water Quality Indicators report)

4.3.3 Variables Measured for Marine Water Samples

The Irish (and other EU countries) surface water monitoring programmes assess up to 100 different chemical and physical parameters on water and sediment samples in the various marine monitoring programmes, more than half of the variables being different organic micropollutants.

The water quality variables of some relevance to morphology can be grouped into the following broad categories:

- Basic variables (e.g. salinity, water temperature, pH, conductivity, dissolved oxygen) used for a general characterisation of water quality.
- Suspended particulate matter (e.g. suspended solids, turbidity and organic matter).
- Indicators of eutrophication: nutrients, dissolved oxygen and various biological effect variables (e.g. chlorophyll a, Secchi disc transparency, phytoplankton, zoobenthos).
- Biological indicators of the environmental state of the ecosystem (e.g. phytoplankton, zooplankton, zoobenthos, fish, macrophytes).

Few of these 'pre-WFD' variables are directly relevant to morphology. However some can be used as surrogates for baseline morphological information. Depth, sediment type, flow and salinity can provide a reference for morphological conditions at a specific point in space and time that can be compared. Turbidity or suspended solids can also give an indication for the type of water body being assessed.

Basic Variables

Most of the marine monitoring programmes in Europe include measurements of basic variables such as water temperature, salinity, dissolved oxygen and pH. In many monitoring programmes basic variables are measured very frequently, typically bimonthly sampling, though in Ireland the frequency has varied dependant on the programme. Salinity results may be used is to provide baseline data as well as indications of where there may have been changes to morphology (e.g. extensive tidal channel realignment / land claim). This information should be assessed on a water body basis. The use of this surrogate time series data can only assist in identification of possible recent changes until long term monitoring data for morphology is available.

Suspended Particulate Matter

Suspended solids and turbidity can give an indication of the type of water body environment. The level of turbidity is a significant environmental stress that defines the ecology. Changes in turbidity can be an indicator of changes in morphology or erosion. However, it is important to note that these changes may be attributed to changes in morphology upstream or in adjacent water bodies. Investigative monitoring can help identify the exact source.

The suspended sediments can give an indication of morphological changes, but only when supported by other information such as flow, depth or marine topographical changes, but could give an early indication of changes. Review of this data should include examination of the water body type and regime. Changes in suspended particulate matter can also indicate morphological changes from upstream of the TraC water bodies and information from adjacent water body development or morphological change should also be examined.

Eutrophication - Nutrients

Eutrophication is a product of increased nutrients. This is usually due to runoff from agricultural land, point source discharges or due to change of land use from cleared forestry or other cover. Intensive land use, maintained drainage ditches and runoff can also contribute to eutrophication, all of which are pressures identified as potentially impacting on morphology. In the absence of other monitoring systems in a water body, eutrophication may act as an indicator of physical alterations. Eutrophication associated algal blooms can reduce flow in certain waters bodies and potentially affect sediment settlement and the morphology of a water body.

All the ten countries reported by EEA (1996) have at least one national marine monitoring programme with the purpose of assessing the concentration of nutrients in the water column. As a rule the monitoring programmes include measurement of nitrogen, phosphorus, and silica. Additionally, the impact of eutrophication is measured using general indicator variables such as Secchi disc transparency (SDT), chlorophyll a and primary production.

SDT can be used as an indicator for suspended sediments which can be related to morphology, however, existing programmes have used this variable to assess algal bloom reducing under water visibility and therefore should only be used if there associated observation records referring specifically to the likely presence of suspended sediments. Future use of such a variable will require nutrient or chlorophyll values to put this variable in context.

Metals

Ireland measures heavy metals in a number of programmes, often linked to others such as shellfisheries or areas where there have previously been levels of concern. The sampling frequency varies from once every third year to 4-5 annual samples. In most cases sample records include observations of depth and sediment type which are crude indicators of morphology, and may provide long term records. Those samples associated with measurement of metals in sediments will have more detailed granulometric information that may assist in the identification of long term morphological trends in the absence of other information. Proposed WFD programmes measuring marine contaminants can also provide future sources of this information.

Measurement of Metals in Sediments

Several of the marine monitoring programmes include measurement of metals associated with the bottom sediment.

This existing sampling programme under the previous National Monitoring Programmes, and noted in the NS-Share Monitoring Database, may be used to give some baseline temporal information to inform marine morphology. Each sample site was assessed for granulometry as well as metals. Granulometry (which can be attributed to sediment type and depth) can be used as a baseline and indicator of change in marine morphology. However, granulometry can also be attributed to natural change, a factor which should be considered when interpreting results. In the absence of a baseline for morphology, these repeat sample points, may provide a time series of depth and sediment type that can be assessed for significant changes. Any change in the overall depth of an estuary or sediment type are indicators of morphological impact (planform, sediment size range and lateral transport process are eco-geomorphologic attributes as defined in Table 5.6 of Chapter 5). By using these surrogates where they occur a time series dataset can be used to assess long term gradual changes, or marked changes can be assessed

Ireland requires the monitoring of dredge material in accordance with the requirements under OSPAR. These sampling results are reported to the regulator and contain detailed information of sediment types, granulometry as well as chemical composition, which may be of use in providing information in the case of future morphological changes, especially as they are associated with a morphological modifying activity. In addition, this monitoring is often associated with a detailed bathymetric survey by the operator of the area dredged for navigation. This associated information provides detailed morphological information of an impacted area.

4.3.4 Environmental Impact Assessments / Investigations

Environmental Impact Assessments and other environmental reports accompanying planning applications, foreshore lease/licence and dumping at sea applications can provide good sources of baseline morphological [and ecological] data. Registers of marine models and Environmental Impact Statements (see Appendices 2-1 and 3-2 respectively) completed in Ireland were generated as part of the Literature Review.

4.3.5 Conservation Monitoring

In addition to the various water quality monitoring programmes, Ireland also reports to Europe on conservation status of protected areas and species under the Habitats and Birds Directives (92/43/EEC and 79/409/EEC respectively). In compliance with the Habitats Directive, the NPWS evaluate and report on the conservation status of Special Areas of Conservation and Annex II species at 7 year intervals. This differs from the WFD 6-year River Basin Management cycle. However, a programme of Site Inspection Reporting (SIR) is carried out by the NPWS on a 3-year cycle. SIR is the process by which activities and their impacts on designated sites are recorded by NPWS Conservation Ranges. The data collected details the overall condition of the site and lists the activities that have influenced its integrity. Protected areas currently include a range of coastal dune and saltmarsh habitats.

The WFD will help ensure that where morphology and morphological pressures are a contributing factor; this programme can provide information to assist assessment in the future.

There are several techniques for the monitoring of these transitional and coastal habitats, dependant on their location and type. In Ireland the monitoring is currently carried out by transect or point samples for which a variety of information is recorded, including the physiotope. The physiotope is an assessment of the physical habitat in which the ecology is associated. In most of the biotope (physical and biological) recording schemes this information is used to classify the ecology of a specific area. In TraC habitats this would include recording of substrate, possibly including detailed granulometry, likely exposure etc. These are all essential elements to indicate changes in marine morphology by indicating changes in sediment regimes or erosion/deposition processes and important information on potential ecological indicators of changes.

4.3.6 Post-WFD Monitoring Programmes

Floods Directive

Under the new Floods Directive (2007/60/EC) there are expected to be a number of parallel national studies looking at coastal topology and flood risk. The surveys are currently planned or underway and employ LiDAR surveys with orthophotography. The work is being carried out in conjunction with the OPW and Coastal Engineering Division of DAFF (the former DCMNR). The results of the first area studies are due at the end of 2008. However these could provide significant nearshore information of existing baseline conditions to inform morphological assessment.

INFOMAR (and the Irish National Seabed Survey (INSS)

The programme is a joint survey run by the GSI and Marine Institute and built on the physical mapping programme of Irelands offshore waters (beyond 50m depth) the Irish National Seabed Survey (INSS 2000-2006). The INFOMAR programme, an extensive of the INSS, will provide full coverage in a large number of selected inshore areas by 2013 (Marine Institute and GSI, 2006). INFOMAR will initially focus on 26 priority bays and three priority areas around the coast (Figure 4.3) The INFOMAR programme began in the summer of 2006 with surveys of valuable fishing and fish farming areas in Bantry Bay, Dunmanus Bays and fish spawning areas off the South West Coast (GSI, 2007). In early 2007, the survey began to extend coverage of the biologically sensitive area off the Dingle Peninsula and continued mapping Galway Bay and Waterford Bay. The survey plan continues in 2008 to include surveys of Dublin Bay, Carlingford Lough, Donegal Bay and Sligo Bay (Figure 4.3)

Figure 4.3: Priority INFOMAR areas (Source: Marine Institute 2007)

For each of the bays surveyed this project will deliver hydrographic maps illustrating all types of features from sandbars to underwater canyons and cliffs; seabed classification maps showing the type of sediment on the seabed, for example sand and gravel deposits which could provide potentially valuable marine aggregates for the construction industry; and habitat maps.

These maps will be integrated with the outputs from the INSS (Irish National Seabed Survey) which covered the offshore area of Ireland. These integrated maps will allow planning for sustainable development of Ireland's 220 million acres of seabed and protect biologically sensitive areas and resources.

INFOMAR provides key baseline data to support coastal and inshore development. The data collected can also be used to input into tidal models and carrying capacity models which can be used as the marine morphological baseline from which changes can be monitored

4.4 Water Framework Directive Monitoring Programme for TraC Waters

As noted previously, the EPA prepared a report titled "Ireland – Water Framework Directive Monitoring Programme" (2006) to meet the requirements of the WFD, the National Regulations Implementing the Water Framework Directive (SI no 722 of 2003) and the National Regulations implementing the Nitrates Directive (SI no 788 of 2005). This document sets out the roles and responsibilities and tasks required to implement the monitoring programmes which are assigned to various bodies within the state as required under the National Regulations.

The EPA (2006) outlined the quality elements to be monitored by the WFD programme. With regard to hydromorphology, the EPA summarise the following for which the EPA, Marine Institute and OPW have responsibilities for:

Tidal Regime: ***'can be monitored on a national basis by a series of tide gauges located around the coast and overseen by the Marine Institute. The criteria for evaluating status have not yet been determined'***.

Freshwater Flow*:* ***'High precision, high frequency monitoring will be required for the long-term trend and flux sites (OSPAR and lakes). Automatic gauges will be used for these subnets. Lower precision measurements may be sufficient for other subnets – e.g. well-calibrated staff gauges with good ratings to enable flows to be determined on the day of sampling if the gauge is read accurately'***.

Morphological Conditions: 'are described in the directive as the depth variation, structure and substrate of the seabed and condition of the intertidal zones. In view of these assessment criteria, a research project, under the auspices of the Programmes of Measures Working Group, is underway to establish which morphological indicators might best describe the conditions in coastal and transitional monitoring programmes and respond to the pressures that might act specifically on the morphology of a water body e.g. dredging (fishing, channelisation) or coastal defences. In addition the project will define the relationship between morphology characteristics and biological status and develop a decision support tool for regulators to assess the potential impact of future developments on individual water bodies, (i.e. to prioritise activities and establish a tiered assessment system).

Details outlined for morphological conditions can be informed by the Marine Morphology PoMS study. Chapter 5 introduces the relationship between morphological features and processes and the pressures identified. Recommendations relating to morphological indicators are then made in Chapter 9, and Chapter 11 outlines how the findings of this study can be used to support Ireland's regulatory decision framework.

The biological elements and associated classification tools identified as sensitive to hydromorphology are identified by the EPA (2006) as follows:

Macro-algae – Reduced Species List (Reponsible body: EPA - in progress)
Species richness can respond to changes in hydromorphology. This tool will include measures of the number of species present on a shore and the ecological status of these species. Changes in the numbers will indicate changes in the ecological status of the area. Three to five sites in each identified water body will be monitored once every 3 years.

Seagrass – Intertidal Spatial Extent, Density and Diversity (Responsible body: EPA/NPWS - in progress)
Seagrass communties respond to physical disturbances. Likely responses include reduction in species diversity and habitat extent. Initial surveys will be on an annual basis, and once background data has been accumulated, this will be reduced to a 3 year cycle

Saltmarsh – Spatial Extent (Responsible body: EPA/NPWS; in progress)
Common in transitional waters and coastal lagoons, saltmarsh is particularly susceptible to habitat loss through erosion. Monitoring for the purpose of the WFD is based on simplified version of habitat mapping techniques (habitat extent and bed diversity). Depending on the size of the saltmarsh, habitat monitoring will take place at 1 to 3 locations in each identified water body on a 3 year cycle.

The EPA considered all 309 transitional and coastal water bodies for inclusion in the national WFD coastal and transitional waters monitoring programme. The number of water bodies within each River Basin District and each typology is shown in Table 4.3 and the locations shown in Figure 4.1. In accordance with the Water Framework Directive and guidance provided by the Common Implementation Strategy, a representative number of water bodies were selected that were considered to provide an assessment of the overall status of Ireland's transitional and coastal waters and to meet the other specific requirements of the WFD.

Table 4.3 Number of Transitional and Coastal water bodies by type in Ireland (EPA, 2006)

River Basin District	Typology						
	TW 2	TW 6	CW 2	CW 5	CW 6	CW 8	CW 10
Eastern RBD	10	3	0	6	1	1	0
South Eastern RBD	16	5	2	4	0	3	0
South Western RBD	29	14	9	9	0	3	6
Shannon IRBD	14	6	4	4	0	1	2
Western RBD	21	47	5	15	0	5	5
North Western IRBD	14	8	4	12	0	6	1
Neagh Bann IRBD	6	3	1	3	0	1	0
Total by Type	110	86	25	53	1	20	14

The structure of the WFD monitoring for TraC water bodies is outlined. However, as noted above, elements of the monitoring programme to be undertaken by the Marine Institute have not yet commenced as a result of funding issues.

The programme describes three types of monitoring; Surveillance Monitoring (SM), Operational Monitoring (OM) and Investigative Monitoring (IM). The monitoring frequencies proposed are designed to provide meaningful data for the assessment of surface water status.

Coastal and Transitional Surveillance Monitoring Network

A selection or 'subnet' of Surveillance Monitoring water bodies was chosen to represent the range of significant pressures and typology scenarios present in Ireland's coastal and transitional waters. The subnets were also chosen with the objective of assessing natural and long-term trends.

A frequency of 6 years is proposed for hydromorphology monitoring.

Other Overlapping Subnets

Within the structure of the WFD subnets (EPA, 2006) the Surveillance Monitoring programme will also include the following overlapping subnets – overlapping in the sense that they will also be contained in one or more of the four principal subnets above.

- Eurowaternet (EIONET) sites,
- Surface water / groundwater interaction site,
- Selected reference condition sites
- WFD Intercalibration register sites
- EUROSION / IFRAMS networks (Erosion and Flooding mapping)
- Selected NPWS Protected Area sites – see also OM programme

Individual monitoring points may be included in one or more of the main subnets.

Coastal and Transitional Waters Operational Monitoring Network

The Operational Monitoring programme is a selection or subnet of representative water bodies from those identified as being 'at risk' or 'probably at risk' of failing to meet their environmental objectives. This selection was further divided into 3 additional subnets for the purposes of assessing the effectiveness of measures to address impacts arising from point, diffuse and hydromorphological pressures, as well as measures to maintain good and high status sites.

The operational programme for transitional and coastal waters has 6 subnets consisting of 80 water bodies (Figure 4.1) (EPA, 2006). A frequency of 6 years is proposed for hydromorphology monitoring.

The Marine Morphology study has further characterised the risk posed to water body status. This could be used to refine the OM programme and focus on those water bodies estimated to at risk of failing to achieve good and / or high ecological status (see Appendix 6-3 for further characterisation results).

Coastal and Transitional Waters Investigative Monitoring Network

No TraC water bodies have been proposed for investigative monitoring. Investigative monitoring is required in situations where the reason for exceedances is unknown, where surveillance or operational monitoring have indicated a failure of objectives and not ascertained the causes. The results of such a monitoring programme will inform the establishment of a PoMs to achieve the required objectives.

In addition to the marine programme, as the proposed revised programme includes the continuation and adaptation of the existing monitoring, information and sample sites for TraC water bodies may overlap with the rivers and lakes monitoring programmes, which have commenced.

Rivers

The Freshwater Morphology PoMS study will make recommendations for the monitoring of morphology in rivers. Consideration and / or adoption of these recommendations should facilitate monitoring of TraC water bodies downstream of any monitoring sites.

A riverine monitoring programme is being undertaken by EPA Regional Inspectorates on behalf of the local authorities. The national monitoring programme includes mainly large rivers and their main tributaries with approximately 1,500 sampling sites in 300 rivers. The aim is to obtain a sampling frequency of 12 times annually, the water samples being analysed for indicators of organic pollution, nutrients and, metals. The biological quality of rivers is monitored according to a national programme operated by the EPA. The biological quality of rivers has been assessed every three to five years since 1971 and existing sample points are likely to be repeated. The third river monitoring activity is an annual recording of fish kills aimed at assessing their causes, which includes salmonid waters and therefore some transitional and coastal water body sites.

A few of the downstream river sampling points are in the transitional waters. Any long term dataset monitoring substrate and depth could potentially be analysed for changes as an indication of changes in morphology which may affect the ecology.

However, due to the nature of morphological conditions the likelihood of natural changes should also be considered.

Lakes and Reservoirs (including Saline Lagoons)

The EPA is continuing the development of a monitoring programme for lakes using aircraft-borne remote sensing. In-situ monitoring of selected lakes and reservoirs is undertaken by local authorities, by the EPA on their behalf, and by the Central Fisheries Board. Though this survey programme only applies to a few TraC sites, of particular importance to marine morphology monitoring is the technology used, which is also being applied to flood mapping and would provide a potentially important dataset for marine morphology assessment. The technology used for shallow water, LiDAR (Light Detection and Ranging, also known as Airborne Laser Swath Mapping or ALSM), can, be applied to coastal waters as well as saline lagoons. Surveys can be repeated to provide rapid assessment of morphological changes, but would only be applicable to intertidal or shallow water areas.

4.5 Conclusions

There are a series of requirements under the WFD which require Member States to monitor and assess the required hydromorphological quality elements. The following outlines how Ireland is currently positioned to meet these requirements, and how the Marine Morphology PoMs study can assist:

- The assessment of pressures and impacts on the morphology of surface waters:
  - Monitoring of the hydromorphological quality elements in TraC water bodies, with the exception of those biological elements listed above, has yet to commence.
  - The relationship between morphology and ecology has been investigated by this study and significant pressures on TraC water bodies identified. The location and extent of these pressures has been mapped where possible which can help inform both surveillance and operational monitoring.
- The restoration and monitoring of those waters significantly impacted by morphological alterations and requirements for the regulation of future engineering activities:
  - In the absence of formally adopted classification tools, the risk to TraC water bodies has been further characterised through the use of TraC-MImAS. Using the results of this assessment TraC water bodies have been prioritised by identifying the potential objectives required of the PoMs, e.g. if a water body requires restoration to at least good ecological status. This information can help refine the selection of monitoring sites.
- The identification and designation of Heavily Modified Water bodies and Artificial Water bodies:
  - The HWMB & AWB PoMS studies have identified water bodies for designation in the absence of monitoring data.
  - The Marine Morphology study can help identify water bodies unable to meet the WFD objectives due to physical alterations, and focus surveillance or even investigative monitoring.
  - If, in the absence of monitoring results, the pressures identified for a water body indicate a significant risk to the achievement of good ecological status the derogations of Article 4 of the WFD may be considered. Failure to comply with the requirements of this Article may justify the need for investigative monitoring.

- River basin management planning - setting of realistic environmental objectives but in balance with important socio-economic activities and industry (flood defence and management, navigation, hydro-electricity etc.):
  - Monitoring of hydromorphological quality elements will not be complete to provide evidence-based classification results for the first RBMP.
  - As noted above, the results of further characterisation have allowed the estimation of objectives for TraC water bodies which may be referred to for the first RMBP. However, monitoring will be required to confirm the base information used and reported by the Marine Morphology PoMS study

Ireland does not have a complete detailed bathymetric and sedimentary baseline in sufficient detail to monitoring changes in estuarine or coastal morphology.

Most of the marine monitoring programmes in Ireland, and the other European countries include monitoring of chemical and physical variables in the water column, and several also include studies of the biota (phytoplankton, zooplankton, zoobenthos, etc.). These sampling networks generally consist of a number of intensive sampling sites, typically less than 20 sites, at which frequent sampling (> 1-12 times/yr) of the water column is made and may be supplemented with an extensive sampling network including several sampling sites and low frequency sampling (1-4 times/yr) of the water column. Zoobenthos and sediment samples are generally taken at numerous sampling sites.

In Ireland the monitoring has predominantly been aimed at monitoring water quality, and quality of water and shellfish. The programmes have been designed to report for European legislation such as the Bathing Water Directive and the Shellfish Waters legislation, details of which are now addressed by the WFD monitoring programme.

The assessment of protected areas often requires a once-off or infrequent assessment of their environmental and biological quality. Whilst these may be part of a larger or national programme, they are not frequently or repetitively sampled. These surveys are separate from the WFD surface water monitoring. In Ireland, the Special Areas of Conservation status monitoring is currently under review, but has been discussed with the National Parks and Wildlife Service (telecom Dr E Kelly, 04/02/2008).

In order to assess changes and variations in morphology a baseline of sediment type and the bathymetric profile and flow must be known. Therefore, from review of the planned monitoring programmes, it is proposed to adapt the existing and proposed programmes and record morphological monitoring surrogates to assist in the compilation of baseline data and monitoring of changes, until such time as a national inshore morphological baseline is available (refer to Chapter 9). This surrogate information (bathymetry, sediment type, exposure and associated ecology where available) can also be used to confirm the morphological classification of the water bodies.

The INFOMAR programme (2007-2013) will complete the Irish National Seabed Surveys work in the inshore areas. Once completed this will provide a detailed baseline for specific bays where changes in morphology can be assessed by targeted re-surveying.

In the meantime it is suggested that morphological data be collected as part of other existing monitoring programmes. The SAC monitoring transects carried out by the NPWS may be levelled to assist not only the detection of changes in morphology, but also identify potential changes in ecology as a result (this is discussed further in Chapter 9).

Point source information can be collected as part of the benthic grab sampling in the Marine Institute's programme. It is also possible that other parts of the programme such as plankton sampling transects, could be coupled with bathymetric or multibeam surveys to detect changes.

There are a number of other programmes proposed such as shallow water LiDAR surveys off the coast which are proposed as flood and coastal defence investigations, from which the data could be used to look at coastal morphology in this context.

5 MORPHOLOGICAL IMPACT METHODOLOGY AND ASSESSMENT TOOL

5.1 Introduction to Morphology / Ecology Relationships in the Context of the WFD... 2
5.2 Transitional and Coastal Morphological Impact Assessment System 11
5.2.1 Module 1: Eco-geomorphic Attributes 13
5.2.2 Module 2: Typology 16
5.2.3 Module 3: Sensitivity Assessment.. 17
5.2.4 Module 4: Impact Assessment (Pressures) 18
5.2.5 Module 5: Capacity Based Scoring System 19
5.3 Pressures 23
5.3.1 Land Claim & Tidal Realignment 24
5.3.2 Dredging, Other Disturbances to Seabed, & Disposal at Sea....................... 25
5.3.3 Piled Structures 29
5.3.4 Flow and Sediment Manipulation Structures.. 30
5.3.5 Impounding Structures & Causeways... 31
5.3.6 Shoreline Reinforcement.. 34
5.3.7 Flood Embankment.. 36
5.3.8 Intensive Land Use 37
5.3.8.1 Salt Marsh Grazing 40
5.3.8.2 Peat Bogs 41
5.3.8.3 Intensive Sea Use 42
5.4 Development & Use of TraC-MImAS for the Purpose of Risk Assessments 44
5.4.1 Clonakilty Harbour (SW_100_0100) 44
5.4.2 Development and approval stages of TraC-MImAS for use as a morphological assessment tool in Ireland 53

This chapter aims to describe the various elements considered by the Marine Morphology Study in relation to the impact assessment of morphology. The current understanding of the relationship between morphology and ecology in the context of the WFD is outlined below, with reference to the Literature Review (Appendix 2-1) and Chapter 2 of this report. The concept and functions of the Scottish EPA's (SEPA) TraC-MImAS tool introduced in section 2.1 are then detailed for each of its five modules. One of these modules is specifically associated with the pressures defined in Chapter 3, and predicts the likelihood that these pressures will impact on the morphological attributes of a water body. Section 5.3 of this chapter summarises how this module of TraC-MImAS considers each identified pressure.

Following this description of TraC-MImAS, an example of how this tool can be used for the purpose of risk assessments is provided using the transitional water body Clonakilty Harbour (SW_100_0100). The various assumptions and calculations made by the five module components are detailed using the pressure footprints identified for this water body.

5.1 Introduction to Morphology / Ecology Relationships in the Context of the WFD

Within the WFD, standards are being derived with respect to ecological quality rather than solely physico-chemical elements. The morphological pressures identified throughout this project (such as land claim, dredging, flow or sediment manipulation structures) are assumed to have some form of impact on the ecology of the marine environment. Therefore, there is a need to identify biological (as well as physical and chemical) data that will inform the development of measures of quality.

The link between morphology and ecology is relatively well established in fluvial environments; however, there is less documented information and scientific research linking morphology to ecology in marine environments. There is a need to review the basics to link the Pressure-Impact (morphological pressure-ecological impact) components of the DPSIR (Driver, Pressures, State, Impact, Receptor) approach, which is discussed in Chapters 6, 7 and 8 of the Literature Review (Appendix 2-1), and subsequently to inform the development of an impact assessment tool. In the context of the WFD, there is a need to understand how changes in the morphological quality elements (resulting from pressures) result in alteration to biological elements, causing them to be disturbed from the reference condition and leading to a deterioration in quality status (see Table 5.1). It is acknowledged that there are currently gaps in understanding many of these linkages, particularly at the water body scale. Future monitoring has the potential to increase understanding of these relationships (as with that of physico-chemical elements).

Table 5.1: Overview of biological quality elements relating to the normative definitions in the WFD (adapted from Implementation of the WFD in TraC waters presentation (D. Jowett) at Coastal Waters Network Workshop December 2003)

Ecological Status	Phytoplankton	Macroalgae/ Angiosperms	Benthic Invertebrates	Fish (transitional water bodies)
High	Undisturbed	Undisturbed	Undisturbed (all sensitive taxa present)	Undisturbed
Good	Slight change from type-specific. No accelerated growth or imbalance	Slight change from type-specific. No accelerated growth or imbalance	Diversity and abundance slightly outside range. Most sensitive taxa present	Slight change in abundance of sensitive species
Moderate	Composition, abundance, biomass bloom (frequency/ abundance) moderately different from type-specific	Composition and abundance moderately different from type-specific	Diversity and abundance moderately outside range. Taxa indicative of pollution present and many sensitive taxa absent	Moderate proportion of sensitive species absent due to anthropogenic impacts
Poor	Biological communities deviate substantially from undisturbed conditions			
Bad	Large portions of biological communities are absent			

The basic underlying assumption is that the presence of species at a location is encouraged or discouraged by the environmental factors occurring at that location. Those factors may be natural; resulting in the presence of a particular community and a certain species richness, or unnatural (brought about by human activities); resulting in a modification of the expected natural communities. Separating natural variability, particularly in dynamic estuarine and coastal environments, from change brought about by human activities is often difficult. A commonly used approach is to develop 'indicator species' which increase or decrease in response to pressures/environmental factors, or are considered to favour or be intolerant of different pressures/environmental factors. The following are relevant 'indicator species' studies identified and noted in section 4.8 of the appended Literature Review 2-1:

- ***Review of current and historical seabed biological time-series studies in the UK and Europe*** (Hiscock & Kimmance, 2003): Ninety-two seabed biological surveys that include time-series data were identified, and a description of each study entered into a time-series database, which is available as front page web browsers on the ***MarLIN*** website (http://www.marlin.ac.uk/time_series_metadata/).

- ***Identification of seabed indicator species from time-series and other studies to support the implementation of the EU Habitats and WF Directives*** (Hiscock ***et al***, 2004). This seabed indicator research was undertaken as a follow-up to the review of the time series studies. The time-series study identified the potential for the data from some studies to describe the change in abundance of a particular marine species in response to anthropogenic activities. The Joint Nature Conservation Committee (JNCC) then commissioned a review (by the UK Marine Biological Association) of existing data to identify indicator species whose change in abundance may help assess the relative impact of anthropogenic activities on marine habitats.

- ***Identification of seabed indicator species to support the implementation of the EU Habitats and WFD Directives 2nd Edition*** (Hiscock ***et al***, 2005a***).*** Information from further review of literature was collated into 'A Seabed Indicators Species' database which is available on the web to search information on species habitat, impact and literature gathered in the report, http://www.marlin.ac.uk/indicatorsp/Indicator_search.php. This study is relevant to the north-east Atlantic, and is associated with predominately estuarine and near shore habitats.

- ***Development of a hard substratum benthic invertebrate Water Framework Directive compliant classification tool*** (Hiscock ***et al***, 2005b***)***: Findings of this report can also be searched using the Seabed Indicators Species database.

Although Hiscock (2005a) reported that there is a significant amount of information available for identifying indicators for physical disturbance, it was recommended that "a greater range of faunal and floral groups should be assessed to broaden the scope for determining indicator species such as macroalgae and angiosperms (such as sea grasses)" (Literature Review Appendix 2-1, 13.4).

Work undertaken through ***MarLIN***, and other projects such as SensMap and BioMar have also focused on the 'biotope' scale of habitat and species communities, all of which were identified as useful reference points in the Literature Review (Literature Review Appendix 2-1, Chapter 2).

The basic ecological concepts evaluated within ***MarLIN*** and SensMap can be summarised as frequency/intensity of impact, sensitivity and tolerance of species.

Before discussing the ecological links between biology and morphology, it is useful to define some of the basic concepts that recur in recent studies, such as ***MarLIN*** and SensMap:

Recoverability is the ability of a habitat, community or species to return to a viable state which is at least close to that which existed before the development, activity or event. Recovery may occur through re-growth, re-colonisation by migration, or juveniles settling from undamaged populations. Recovery can be partial or complete.

Sensitivity is the intolerance of a habitat, community or individual of a species to damage, or death, from an external factor. Sensitivity refers to specific environmental perturbations.

Vulnerability expresses the likelihood that a habitat, community or individual of a species will be exposed to an external factor to which it is sensitive, and indicates the likely severity of damage should the factor occur at a defined intensity and/or frequency.

These factors (in terms of biology) are strongly linked to the frequency and intensity of physical disturbances, which may result from morphological pressures, such as:

Substrate Loss – Substrate occupied by the species or biotope under consideration is removed. Species or community recovery assumes that the substrate within the habitat preferences of the original species or community is present or recovers.

Smothering – Where an area of a biotope is smothered by sediments or impermeable materials, such as concrete, oil, or tar.

Physical Disturbance and Abrasion – This factor includes mechanical interference, crushing, physical blows against, or rubbing and erosion of the organism or habitat of interest.

Other impacts resulting from pressures, identified by ***MarLIN*** (Tyler Walters and Hiscock, 2005), may include; changes in suspended sediment, desiccation (linked to changes in emergence regime), changes in water flow rates, changes in turbidity (strongly linked to changes in suspended sediment), changes in wave exposure, and displacement. The effect of any given activity on an environmental factor is dependant on the site or location of that activity. Similarly, the magnitude, duration, frequency and extent of the change in an environmental factor will be dependant on:

- the type of activity;
- its scale;
- its extent and magnitude;
- its duration and frequency, as well as;
- the nature of the receiving environment, and hence;
- the location of the activity.

Both ***MarLIN*** and the SensMap project have produced matrices linking coastal activities with the environmental factors likely to change as a result of these activities. These matrices are outlined in Tables 5.2 and 5.3 below.

Table 5.2: *MarLIN* – Maritime and coastal activities to environmental factors matrix (Tyler-Walter et al, 2002)

		ENVIRONMENTAL FACTORS – Physical													Chemical							Biological			
Coastal & Maritime Activities / Events	**Sub-activites /events**	Substratum loss	Smothering	Suspended sediment	Desiccation	Changes in emergence regime	Changes in water flow rate	Changes in temperature	Changes in turbidity	Changes in wave exposure	Noise disturbance	Visual presence	Abrasion / Physical disturbance	Displacement	Synthetic compound contamination	Heavy metal contamination	Hydrocarbon contamination	Radionuclide contamination	Changes in nutrient levels	Changes in salinity	Changes in oxygenation	Introduction of microbial pathogens / parasites	Introduction of non-native species	Selective extraction of target species	Selective extraction of non-target species
Aquaculture	Fin-fish		R	R			R		R		P	P	R		R				R		R	R	R		
	Macro-algae		P	P			P		P		P	P							P		P	R	R	R	R
	Predator control										R	R			P										
	Shellfisheries		R	R			R		R		R	R	R		R				R		R	R	R	R	R
Climate change	Current change						R	R	R										R	P		R	R		
	Sea level change				R	R	R			R										R					
	Temperature change				R			R	R										R		R	R	R		
	Weather pattern change				R			R														R	R		
Coastal defence	Barrage	R	R	R	R	R	R		R	R	R	R	R	R	P	P	P		R	R	R				
	Beach replenishment	P	R	R	R	R	R		R	R	R	R	R	R	P	P	P		R		R				
	Groynes	P	P	R	R		R		R	R		R		P							P				
	Sea walls / breakwaters	P	P	R	R	R	R		R	R		R		P							P				
Collecting	Bait digging	R	R	R	R				R		R	R	R	R										R	
	Bird eggs										R	R	R											R	
	Curios										P	P	R	R										R	R
	Higher plants	R		R			R				R	R	R	R					R					R	R
	Kelp & wrack harvesting	R		R	R		R		R	R	R	R	R	R					R		R			R	R
	Macro-algae	R			R		R				R	R	R	R	P									R	R
	Peelers (boulder turning)		R		R	R	R				R	R	R											R	
	Shellfish	R	R	R	R				R		R	R	R	R										R	R
Development	Construction phase	R	R	R	R	R	R	P	R	R	R	R	R	R	P	P	P	P	R	R	R				
	Artificial reefs		P	R			R		R	R					P	P	P		R		R				
	Communication cables		P	R			R		R			R													
	Culverting lagoons			R	R	R	R	R	R	P									R	R	R				
	Dock/port facilities		R	R			R	P	R	R	R	R	R	R	R	P	R	P	R	P	R	R	R		
	Land claim	R	R	R	R	R	R		R	R									R	R	R				
	Marinas		R	R	R	P	R	P	R	R	R	R	R	R	R	P	R		R		R	R	R		
	Oil & gas platforms		R				R		R		R	R	R		R	R	R		R		R				
	Urban			R					R		R	R	R		R	R	R		R	R	R	R			
Dredging	Captial dredging	R	R	R	R	R	R		R	R	R	R	R	R	P	P	P	P	R	P	R				
	Maintenance dredging	R	R	R					R		R	R	R	R	P	P	P	P	R		R				
Energy generation	Nuclear power generation		P	R				R	R		R	R			R	P		P	R	P	R				
	Power stations		P	R				R	R		R	R			R	R	P		R	P	R				
	Renewable (tide/wave)		P	P	P	P	R		P	R	P	P			R		P				P				
	Wind farms	R					R			R	R	R	R	R	P	P	P								
Extraction	Maerl	R	R	R			R		R		R	R	R	R					R		R			R	R
	Rock/minerals (coastal quarrying)	R	R	R					R		R	R	R	R	R	R	R		R		R				
	Oil & gas		R								R	R			R	R	R		R		R				
	Sand / gravel (aggregates)	R	R	R			R		R	P	R	R	R	R	P	P	P	P	R		R				
	Water resources (abstraction)				P	P	R												R	R	R				
Fisheries/ Shellfisheries	Benthic trawls (e.g. scallop dredging)	R	R	R					R		R	R	R	R	P	P	P		R		R			R	R
	Netting (e.g. fixed nets)										R	R	R	R										R	R
	Pelagic trawls										P	P												R	R
	Potting / creeling		R								R	R	R	R										R	R
	Suction (hydraulic) dredging	R	R	R					R		R	R	R	R	P	P	P		R		R			R	R
Recreation	Angling										R	R	R	P										R	R
	Boating / yachting								P		R	R	R		R	P	R		R		R	R	R		
	Diving / dive site										R	R	R	R										R	
	Public beach										R	R	R						P						
	Tourist resort			R					R		R	R	R		R	R	R		R		R				
	Water sports										R	R	R		R	P	R								
Uses	Animal sanctuaries										P	P	P						P			P	P		
	Archaeology	R	R	R					R		R	R	R	R	P	P	P		R		R				R
	Coastal farming		R	R					R		R	R	R		R	P	R		R		R	P			
	Coastal forestry		R	R					R		R	R	R		R	P	R		R		R				
	Education/interpretation										R	R	R	R										R	R
	Military										R	R	R		P	P	P	P							
	Mooring / beaching / launching		R	R			R		R		R	R	R	R	R	P	R					P	P		
	Research	P									R	R	R	P	P	P	P		P			P	P	R	P
	Shipping		P	R					R		R	R	R	R	R	R	R	P	R		R	R	R		
Wastes	Fishery & agricultural wastes		R	R					R						R				R		R	R			
	Industrial effluent discharge		R	R					R						R	R	R		R		R				
	Industrial / urban emissions (air)			P					P						R	R	R								
	Inorganic mine and particulate wastes		R	R					R				R		P	R	P	P	R		R				
	Land / waterfront runoff		R	R					R						P	P	P		R	R	R				
	Litter and debris		R										R		P	P	P								
	Nuclear effluent discharge			R					R							R		R							
	Sewage discharge		R	R					R						R	R	R	P	R		R	R			
	Shipping wastes		P	R					R						R	R	R		R		R	R	R		
	Spoil dumping		R	R					R				P		P	P	P	P	R		R				
	Thermal discharges (cooling water)			R				R	R						R	R	P			P	R	P	P		
Other	Removal of substratum	R	R	R	P	P	P		R	P	R	R	R	R	P	P	P		R		R				

Page last updated 18 March 2003

PROBABLE EFFECT	-	R
POSSIBLE EFFECT	-	P

Table 5.3: SensMap - Activities and associated default environmental factors (extract from Cooke & McMath, 2001)

	CHANGES TO GEOMORPHOLOGICAL FACTORS	Substrate	Tidal Flow	Wave Exposure	Emergence Regime	PHYSICAL DISTURBANCE	Displacement	Amputation	Crushing	Abrasion	Entanglement	Collision
EXPLOITATION OF LIVING RESOURCES												
Dredging:												
Hydraulic Dredging												
Intertidal mechanical dredge												
Mussel & oyster dredge												
Scallop dredge												
Higher Plants:												
Picking for human consumption												
Saltmarsh grazing												
EXPLOITATION OF NON_LIVING RESOURCES												
Aggregate Dredging:												
Biogenic gravel (maerl)												
Sand & Gravel												
Metalliferous sediments												
Alternative Energy Production:												
Coastal wave & tidal current												
Tidal barrage												
Wind												
Water Resources & Storage												
Desalination												
Estuarine reservoirs												
Freshwater abstraction												
USE OF COASTAL LAND/WATER SPACE												
Coastal Forestry												
Coast Protection/Defence:												
Beach replenishment												
Breakwater												
Drainage												
Groynes												
Infill												
Managed retreat												
Seawall												
Docks, Marinas & Shipping:												
Anchoring												
Capital Dredging												
Maintenance dredging												
Mooring												
Navigation												
Estuarine Barrages:												
Amenity barrage												
Storm/ tidal surge barrage												
Tidal barrage												
WASTE DISPOSAL												
Agricultural run-off												
Dredge spoil dumping												
CLIMATIC CHANGE												
Current Change												
Sea Level change												
Temperature change												
Weather patterns												

Research into links between morphological conditions, ecological functions and biology have typically been carried out with links to practical applications, and often supported by European funding. There are a number of large-scale projects for mapping biotopes and sensitivity that are ongoing, or are recently completed within the EU (see Table 5.4). Many were driven by the EU Habitats Directive, but provide information which may be useful to the WFD once any problems of scale are identified and accounted for.

Table 5.4: Summary of recent large-scale projects related to Marine habitat mapping in Ireland (as detailed in Appendix 2-1, Chapter 2).

Project	Area	Timescale	Summary
MarLIN (The Marine Life Information Network) - Species and Habitats	UK and Ireland	Ongoing, started 1998 by Marine Biological Association	Key information reviews and sensitivity assessments of species and habitat biotopes. Impact of human activities on benthic biotopes and species.
BioMar - Benthic marine species survey	Ireland	1992-1996	Largest marine ecological seabed survey of the Republic of Ireland. Data provided the basis for classification of marine biotopes in the North East Atlantic, and the selection of marine Special Areas of Conservation.
SensMap	Ireland and Wales	1996-1999	SensMap produced and brought together new data on marine seabed habitats, communities and species, including biotope mapping. Developed a protocol to assess sensitivity of individual marine species and areas of benthic marine life to a broad range of maritime activities. UK data provided the basis for biotope classification (limited input from Irish data)
MESH - Mapping European Seabed Habitats	UK, Ireland, France, Netherlands, Belgium	2004-2007	Produced an array of products related to seabed habitat mapping, including WebGIS seabed habitat maps with physical and biological data.
Irish Sea Pilot and UKSeaMap	UK and Ireland	2002	Identified and maped main marine landscapes. Summarised characteristic biological communities, where possible. Evaluation of marine landscapes in relation to their susceptibility to human activities. Links to MESH.
Marine Habitat Classification	Britain and Ireland	2004	National classification of benthic marine habitats (seashore and seabed habitats and their associated communities of species) for Britain and Ireland - building from BioMar.
UK Marine SACs project	UK	completed 2001	Support for management of Marine SACs. Information on their ecology, sensitivity and management.
INFOMAR and Irish National Seabed Survey (INSS) (initially focused on 26 priority bays)	Ireland	INSS completed 2007; INFOMAR commenced 2006	INSS & INFORMAR: Mapping of Irish seabeds: - bathymetric maps - seabed geology/ classification maps INFOMAR - habitat maps
HabMap - Habitat mapping for conservation and management of the Southern Irish Sea	Ireland	2005-2008	The HABMAP project has produced working habitat maps of the seabed of the southern Irish Sea, and has developed a model that uses physical characteristics to predict the biological community/biotopes

Of these projects, ***MarLIN*** has produced the most comprehensive information linking the impacts of physical pressures on marine biology, through producing 932 species and habitats reviews. As noted above, ***MarLIN*** published a report identifying seabed indicator species to support implementation of the Habitats Directive and WFD (Hiscock ***et al*** 2005a). An example of a sensitivity review for a key species to physical factors is illustrated in Table 5.5 below. Each underlined heading within Table 5.5 hyperlinks to further detail documented by ***MarLIN***.

Table 5.5: Physical Factors - Species review for Common eelgrass, *Zostera marina.* Excerpt from *MarLIN* species review for Seagrasses

	Intolerance	Recoverability	Sensitivity	Evidence/Confidence
Substratum Loss	High	Very low	**Very High**	Moderate
Smothering	High	Very low	**Very High**	Moderate
Change in suspended sediment	Intermediate	Moderate	Moderate	Moderate
Desiccation	Intermediate	High	Low	Moderate
Change in emergence regime	Intermediate	High	Low	Low
Change in water flow rate	Intermediate	Moderate	Moderate	Low
Change in temperature	Tolerant	Not Relevant	Not sensitive	Moderate
Change in turbidity	High	Very low	**Very High**	Very low
Change in wave exposure	High	Very low	**Very High**	Low
Noise	Tolerant	Not Relevant	Not sensitive	Very low
Visual Presence	Tolerant	Not Relevant	Not sensitive	Very low
Abrasion & physical disturbance	Intermediate	Moderate	Moderate	Moderate
Displacement	High	Low	High	Low

Another approach that uses species sensitivity in response to pressures is the AMBI (Marine Biotic Index), which uses benthic macroinvertebrate community status as a biological indicator of disturbance (impacts and quality status of soft-bottom marine communities). Macrobenthos are considered a good indicator of disturbance as species respond rapidly to stressors, they are relatively sedentary, long living, and show differing tolerances to disturbance. The index has been developed to respond to water quality and pollution disturbance, but may be able to indicate areas where levels of sediment deposition are increased, resulting in benthic infaunal community shifts where communities shift from suspension feeders to dominance by deposit feeders. This is often seen as a lessening of environmental quality as communities become dominated by taxa perceived as pollution tolerant. Research using AMBI (Borja et al 2003) has shown that recovery of indicator species after disturbance usually follows a pattern of; increase in abundance; then increase in diversity, and finally a change in species composition from tolerant to sensitive taxa. This bears a resemblance to the quality statements given in Table 5.1.

The review of recent seabed mapping projects and development of links between habitat and species in marine environments shows that there are sound theoretical bases for assuming that changes to morphology brought about by pressures will have resulting impacts on ecological and biological features, and for the first round of river basin planning, we may need to use tools that focus on these general links. There is a lack of suitably detailed baseline data to currently utilise the methods developed in programmes such as ***MarLIN*** for the WFD, and there are still issues to be resolved between the impact on specific biotopes and at the water body scale as a whole. As part of the WFD monitoring programme however, seagrass and benthic monitoring will be carried out; both of which will significantly contribute to the understanding of the relationship between ecology and morphology. Monitoring programmes that link morphological and biological surveys at the water body scale can improve the knowledge and assessment of these issues. In summary: “Better understanding of the links between hydromorphology and ecology (via monitoring) is needed” (WFD and Hydromorphology, European workshop, October 2005, Prague).

5.2 Transitional and Coastal Morphological Impact Assessment System

As noted in section 2.1 of this report, an impact assessment tool for the purpose of estimating the risk posed by morphological alterations to the ecological status of TraC water bodies, TraC-MImAS, was developed by SEPA in response to the absence of suitable data to empirically derive standards for morphological conditions. The Marine Morphology PoMs team have been involved in the development of TraC-MImAS through participation in the UK-TAG TraC Morphology Steering Group and TraC MImAS Technical Panel. The TraC-MImAS tool development team consisted of representatives of SEPA, Environment Agency, RPS Consulting and Jacobs, with SEPA staff leading the development. Further to this work the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) commissioned an external interim technical review of the technical reports produced during the development of TraC-MImAS. This detailed review was undertaken by Mr. Anton Edwards of Metoc plc (environmental consultancy) at the end of 2007.

The TraC-MImAS tool was developed with the intention to help regulators determine whether changes to the morphology of TraC waters could pose a risk to ecology, and thereby identify those proposals that could;

- Threaten the aim of achieving ‘good ecological status’; or
- Result in a deterioration in ecological status

There are, at present, no environmental standards available to assess the ecological impacts of alterations to the morphology of TraC waters, and regulatory decisions relating to morphology are largely based on expert judgement. The TraC-MImAS tool was developed in response to the current lack of ecological data required to support development of ‘evidence-based’ environmental standards for morphology. Of relevance to this, it was noted by A. Edwards (2007) that although it is clear that many morphological pressures have the potential to affect aquatic ecology; “there is also considerable weakness in the conceptualising and quantitative modelling of links between ecology and hydromorphology”.

The TraC-MImAS tool is not intended to provide a detailed assessment of ecological status, but rather provide a means of identifying where ecological conditions are likely to be impaired through impacts to morphology, i.e. it is based on the assumption that an assessment of impacts on ecologically relevant features and processes can be used to protect morphology and ecology (SEPA, 2007).

The tool uses a concept of 'system capacity' (allowable morphological change) to measure impacts to morphological conditions, assuming that completely pristine TraC waters have a measure of assimilative 'capacity', which can be degraded by anthropogenic activities. SEPA have defined 'system capacity' as:

A measure of the ability of the water environment to absorb morphological alterations. The likelihood (or risk) that morphological and ecological conditions are degraded will increase as system capacity is consumed. This concept does not infer that degradation of the environment is acceptable; rather it assumes that there is a degree to which minor changes can be tolerated by the system.

TraC MImAS comprises of 5 modules which combine to estimate the existing system capacity (%) of a water body, refer to Figure 5.1 below.

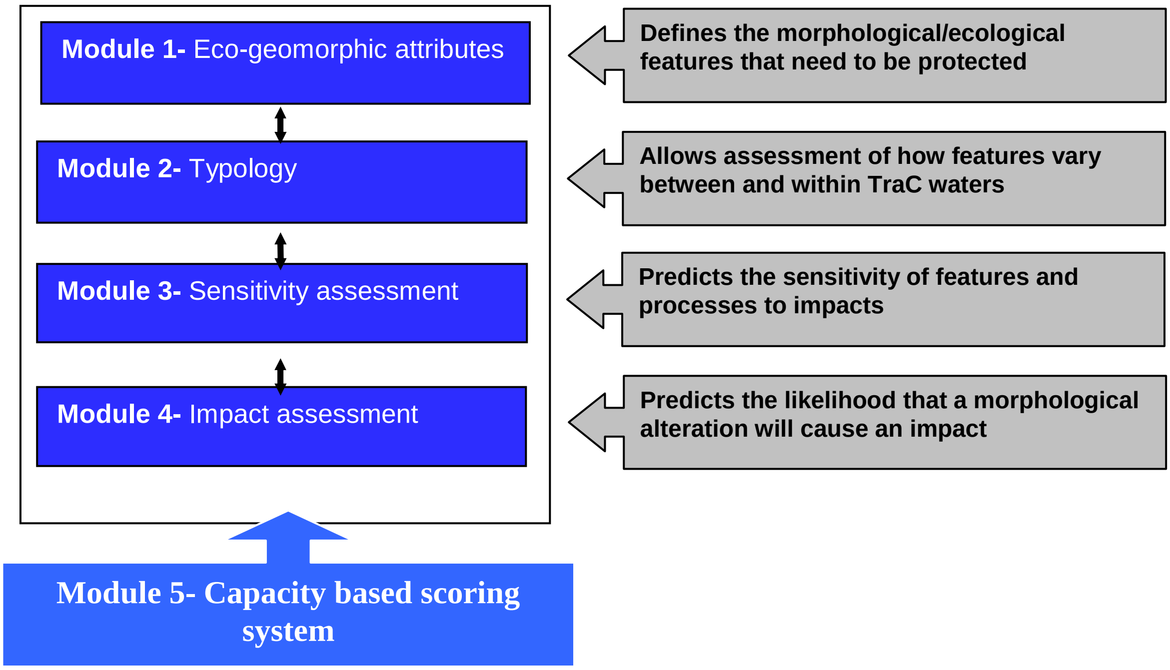


Figure 5.1: Overview of MImAS Modular Components

The capacity used by a water body is estimated for three zones; hydrodynamics, and the intertidal and subtidal zones.

SEPA's TraC-MImAS technical report and appendices titled 'Development of a Decision Support Tool for Regulating TraC Waters under the WFD version a4' outlines in detail the various components of MImAS. At the time of writing, this report had yet to be formally signed-off by UKTAG, and therefore 'does not necessarily represent the final or policy positions of UKTAG or any of its partner's agencies'.

TraC-MImAS is underpinned by a series of assumptions which should continue to be assessed throughout the future application of this tool:

1 A TraC water body has some capacity to accommodate morphological change without changes to its ecological status.
2 There is a relationship between the extent of morphological alteration and the impact on ecological status
3 The response of a water body's morphology to an engineering activity or other pressure is predictable for that type of water body
4 The response of the ecology to morphological change is predictable and depends on the sensitivity of the ecology of the water body.

In development of TraC-MImAS, ***MarLIN*** was a key resource reviewed by SEPA for consideration of the eco-geomorphic attributes and sensitivity assessment. Similarly to matrices produced by ***MarLIN*** and the SensMap project, TraC-MImAS links the identified pressures with those eco-geomorphic attributes considered likely to change as a result of the pressure (taking account of the above assumptions).

The modules of TraC-MImAS are detailed in the following sections (5.2.1 – 5.2.5). To demonstrate further how these modules are applied in practical terms, an example using Clonakilty Harbour in West Cork is provided in the subsequent section 5.4.

5.2.1 Module 1: Eco-geomorphic Attributes

A list of eco-geomorphic attributes representative of the intertidal, subtidal and hydrodynamic zones of TraC waters were selected by SEPA in consultation with the technical panel and project steering group for assessment by MImAS (Table 5.6). Each attribute was chosen "for its role in the direct or indirect support of ecological communities and the supporting processes needed to create and maintain the physical environment on which ecological communities depend" (SEPA, 2007 version a4) and relevance to the morphological quality elements specified by Annex V of the WFD (Table 5.7).

Table 5.6: Eco-geomorphic attributes defined for use by TraC-MImAS (Extract from draft SEPA (2007) TraC-MImAS Technical Report (Rev a4))

Eco-geomorphic Attributes	Definition
Hydrodynamics	**Describes the influence of the tides, waves and freshwater inflow**
Tidal range	***The height that the sea rises and falls over a tidal cycle***
Currents	***Currents associated with the rise and fall of the tide***
Freshwater flow	***Riverine input into TraC Waters, maybe modified by human interference of catchment hydrology/landuse changes***
Flushing/exchange	***The length of time it takes for a transitional water or sea loch to exchange its water***
Salinity/mixing/stratification	***Occurs in transitional waters and sea lochs where freshwater input is important***
Waves	***Waves are important in driving sediment transport processes***
Intertidal Zone	**Describes the size and structure of the intertidal zone**
Geometry	Describes the spatial extent and form of the intertidal zone
Planform	***Aerial view showing planar area of the intertidal zone (2D perspective). Describes the outline and spatial extent, or area of the intertidal zone which can change in response to prevailing coastal processes and/or realignment of the high water mark due to engineering activities.***
Profile	***Cross sectional form of an estuarine channel or gradient of the shoreline.***
Morphological features and substrate	Describes the shape and character of geomorphological features, and the size, structure and sorting of the intertidal sediments
Nature and extent of coastal features	***Topography and geomorphological and vegetation features of the coastal zone e.g. saltmarsh, seagrass, sand dunes, mudflats, sand bars, spits.***
Natural sediment size range	***Is the sediment size distribution natural***
Continuity and sediment supply	Assesses interruptions to coastal processes and sediment supply
Longitudinal sediment transport processes	***Describes sediment mobilization pathways i.e. transport of material by littoral drift from adjacent water bodies.***
Lateral sediment transport processes	***Includes land to sea connectivity and describes inputs and outputs of sediment from erosion of cliffs, catchment derived input from fluvial sources and material transported from offshore.***
Sub tidal Zone	**Describes the size and structure of the subtidal zone**
Geometry	Describes the spatial pattern and form of the subtidal zone
Planform	***Aerial view showing planar area of the subtidal zone (2D perspective). Describes the outline and spatial extent, or area of the subtidal zone which can change in response to prevailing coastal processes and/or engineering activities.***
Profile	***Cross sectional form of a channel or of the coastal zone perpendicular to the coastline***
Morphological features and substrate	Describes the shape and character of geomorphological features, and the size, structure and sorting of the intertidal sediments
Nature and extent of bed features	***Topography or specific features of the seabed e.g. sand banks, ripples.***
Natural sediment size range	***Is the sediment size distribution natural***
Continuity and sediment supply	Assesses interruptions to coastal processes and sediment supply
Longitudinal sediment transport processes	***Describes sediment mobilization pathways i.e. transport of material by littoral drift from adjacent water bodies.***
Lateral sediment transport processes	***Includes land to sea connectivity and describes inputs and outputs of sediment from erosion of cliffs, catchment derived input from fluvial sources and material transported from offshore.***

Table 5.7: Hydromorphological quality elements for TraC waters as specified in Annex V of the WFD

Transitional Waters	Coastal Waters
Annex V 1.1.3	**Annex V 1.1.4**
Morphological Conditions	
Depth variation	Depth variation
Quantity, structure and substrate of bed	Structure and substrate of the coastal bed
Structure of the intertidal zone	Structure of the intertidal zone
Tidal regime	
Freshwater flow	Direction of dominant currents
Wave exposure	Wave exposure

TraC-MImAS does not require data for the eco-geomorphic attributes defined in Table 5.6, but uses numerical values to define the likelihood and sensitivity of each of these attributes to change. These numeric values are specific to each TraC-MImAS water body type and zone (Typology Module).

The relevance of each attribute to each of the six water body types identified in Module 2 is defined. Those attributes recorded as not relevant in certain water body types are as follows:

- ***Freshwater flushing / exchange*** is not considered as a relevant attribute in sheltered to exposed sedimentary or sheltered to exposed bedrock coastal water bodies. However, it should be noted that Table 1.2.4 of the WFD Annex V specifies ‘freshwater flow’ as a component of the hydro-morphological quality element ‘Tidal Regime’ for coastal waters.
- ***Natural sediment size range*** in the intertidal and subtidal is not considered an important attribute of sheltered to exposed bedrock as high currents or waves are the dominant features in these ‘types’ of water body, removing mobile sediment.
- ***Longitudinal and lateral sediment transport processes*** are not considered important attributes of the intertidal and subtidal zones of sheltered to exposed coastal bedrock water bodies.
- ***Longitudinal sediment transport processes are also not assessed as a relevant attribute of transitional lagoons within TraC-MImAS***.

Although the above attributes were considered to have little relevance to specific water body types for assessment within TraC-MImAS; the potential morphological and ecological sensitivity (Module 3) and likely impact of pressures (Module 4) on these attributes is still documented within TraC-MImAS. Therefore, following further research and liaisons with SEPA, the relevance of an attribute such as freshwater flow may be changed from 0 to 1 to reflect the relevance of that attribute to the characteristics of a water body. This ability to update specific modules of TraC-MImAS can facilitate site specific assessments where evidence suggests that an attribute may be relevant and therefore included within the assessment.

The association of the defined eco-geomorphic attributes with water body types can be further developed as the monitoring of TraC waters progresses. This is discussed further in Chapter 9.

5.2.2 Module 2: Typology

The eighteen TraC water body types defined within Ireland and the UK for the WFD, using System B, were grouped into six overall water body types for development and application of TraC-MImAS (Table 5.8). These groupings were based on an assessment of similarities in physical characteristics and likely responses to morphological alterations. It is intended that these MImAS water body types reflect the presence and character of the attributes identified in the Attribute Module, therefore, those attributes not considered relevant to a water body type are excluded from assessments of that type.

Table 5.8: Grouping of System B-typed water bodies to six MImAS water body types

TraC Type	General morphological characteristics	MImAS Code
CW1 to CW9	Sheltered to exposed, micro to macrotidal	Coastal bedrock
CW1 to CW6	Moderately exposed to exposed, macro-tidal. Sedimentary	Moderately exposed to exposed coast - sedimentary
CW7 to CW9	Sheltered, micro-macrotidal. Sedimentary.	Sheltered coast - sedimentary
TW1 to TW4	Partially to fully mixed, mesotidal to macrotidal, intertidal or shallow subtidal, sand and mud.	Transitional meso to macrotidal
TW5, CW11, CW12	TraC Sea Lochs	TraC Sea Lochs
TW6, CW10	TraC Lagoons	TraC Lagoons

TraC-MImAS relies heavily on the typology of water bodies, a point which was highlighted at the November 2007 MTT meeting, at which the group agreed that the function of this tool would benefit greatly from the further improvement of this module.

For the purpose of the Marine Morphology Study, each TraC water body was assigned a typology from Table 5.8 above, and these are outlined in Section 6.2.2 of Chapter 6. With the agreement of the Marine Morphology Steering Group it is recommended that on completion of the monitoring programme, Irish TraC water bodies are reviewed and re-typed where required. This will help increase confidence in an assessment tool which is based on a water body's physical characteristics and likely responses to morphological alterations. Details of how monitoring results can increase confidence of water body typology are outlined in Chapter 9.

On further development of TraC-MImAS it may be possible to divide a water body into various sub-types to reflect the appropriate baseline conditions. Potential for further development may involve the possibility to increase the sensitivity of a water type if for example a large portion of its area is associated with saltmarsh i.e. the capacity of the water body is likely to be absorbed quicker due to the sensitivity [and conservation status] of saltmarsh habitats.

The typology module does not at present allow for the assessment of specific Protected Areas.

5.2.3 Module 3: Sensitivity Assessment

This module combines the morphological and ecological sensitivity of each of the six water body types to change.

Morphological Sensitivity

The likelihood that an attribute (as defined in Table 5.6) of a particular water body type will change in response to an applied pressure is quantified by estimating the resilience (ability to recover from change) and resistance (ability to absorb change) of that particular attribute to change.

- Resilience:
  - 1 (low) = system/feature is unlikely to recover to a pre-disturbance state or dynamic
  - 0.5 (moderate) = system/feature will potentially recover to a pre-disturbance state or dynamic
  - 0 (high) = system/feature is likely to recover to a pre-disturbance state or dynamic
- Resistance
  - 1 (low) = System/feature likely to respond to disturbance
  - 0.5 (moderate) = System/feature will potentially respond to disturbance
  - 0 (high) = system/feature unlikely to respond to disturbance

The minimum value estimated for resilience and resistance is then used to estimate the morphological sensitivity of each relevant eco-geomorphic attribute as follows:

0 = insensitive
0.5 = sensitive
1 = highly sensitive

Ecological Sensitivity

To estimate ecological sensitivity relating to all WFD biological elements the likelihood that a disturbance to individual attributes (via pressures) will result in a degradation of community of species integrity is quantified. The sensitivity values used are 0 = insensitive; 0.5 = sensitive; and 1 = highly sensitive.

It is important to note here that on removal of a pressure from a water body the ecological system may not be characteristic of a reversible system and in some cases may even return to a different ecological state (A. Edwards, 2007). It is considered that this sensitivity module will benefit greatly if updated using information obtained from monitoring programmes.

5.2.4 Module 4: Impact Assessment (Pressures)

This module forms a distinction between intensity and extent of impact and comprises two components:

- Likelihood that a morphological alteration will have an impact on an eco-geomorphic attribute

- Zone of impact: whether impacts are likely to be contained within the vicinity of the pressure, or likely to extend beyond the local vicinity of the pressure. Three categories are defined for use in TraC-MImAS; hydrodynamic, intertidal zone and subtidal zone.

The morphological alterations (pressures) considered by TraC-MImAS are listed in Table 2.1 of Chapter 2. For each of these pressures the likelihood that they will result in an impact on an attribute is estimated and quantified. For example, disposal at sea is scored as unlikely to result in an impact on tidal range and therefore assigned a value of '0', whereas land claim is considered highly likely to impact on the tidal range of a water body.

The Marine Morphology Steering Group identified some issues relating to the numeric values defined for the 'zone of impact'; details of which were passed on to SEPA and considered by the Technical Panel and Steering Group during the development of TraC-MImAS. SEPA (pers comm. S. Greig) responded by noting that it is correct to conclude that in some cases a whole water body will not be affected if the activity is small in nature. However, in assessing the impact to a water body, the zone of impact is combined with the footprint of the pressure, hence, pressures with a high zone of impact but small footprint will have a smaller impact on the water body than similar pressures over a greater area. SEPA also emphasised that some small scale works can affect a whole water body, e.g. works occurring in narrow parts of estuaries. The current TraC-MImAS tool cannot adequately address these situations.

The assessments within this module are independent of water body type; it is in combination with the Sensitivity Module that impact assessment becomes water body type specific.

5.2.5 Module 5: Capacity Based Scoring System

This module combines the outputs from all the above modules to quantify an estimated impact rating for a particular water body.

For each pressure type, an impact score is firstly calculated for each attribute relevant to that pressure using the equation summarised below.

Relevance	X	Ecological Sensitivity	X	Morphological Sensitivity	X	Likelihood of Impact
Output from typology module		***Output from sensitivity module***		***Output from sensitivity module***		***Output from pressure module***

These impact scores are averaged for the attributes within each water body zone (hydrodynamic, intertidal and subtidal) and then multiplied by the zone of impact to estimate the overall impact rating for each pressure within each water body type. The equation used to calculate this impact is summarised below.

Impact rating	=	Relevance	X	Ecological Sensitivity	X	Morphological Sensitivity	X	Likelihood of Impact	X	Zone of Impact
		Output from typology module		***Output from sensitivity module***		***Output from sensitivity module***		***Output from pressure module***		***Output from pressure module***

The percentage capacity used within a water body can then be estimated by combining the impact ratings of the existing pressures with the 'footprints' calculated for each i.e. the length or area over which a pressure extends.

The equation used within TraC-MImAS to calculate the percentage capacity used is summarised as:

$$\text{Capacity Used (\%)} = \sum n \left(\frac{\text{Impact rating} \times \text{Footprint of morphological alteration}}{\text{Length/area of assessment unit}} \right) \times 100$$

Where 'n' is the number of morphological alterations within the assessed area.

The percentage capacity for each zone is calculated as follows:

Hydrodynamics:

- the sum of all pressure footprints (e.g. land claim and causeways) within both the intertidal and subtidal zones are multiplied by the impact rating estimated for hydrodynamics then divided by the ***water body area***

Intertidal Zone:

- linear pressure footprints (e.g. embankments) within the intertidal zone are multiplied by the impact rating for the intertidal, then divided by the ***shoreline length***
- areal pressure footprints (e.g. land claim) within the intertidal zone are multiplied by the impact rating for the intertidal, then divided by the ***intertidal area***

Subtidal Zone:

- linear pressure footprints within the subtidal zone are multiplied by the impact rating for the subtidal, then divided by the ***shoreline length***
- areal pressure footprints within the subtidal zone are multiplied by the impact rating for the subtidal, then divided by the ***subtidal area***

In the absence of Environmental Standards for morphology, TraC-MImAS uses Morphological Condition Limits (MCLs) to help quantify the potential risk that a new morphological alteration could impair achievement of the ecological objectives of the WFD. SEPA define the MCLs as "***thresholds of alteration to morphological conditions beyond which there is a risk that the ecological status objectives of the WFD could be threatened***". MCLs are expressed in terms of % capacity of a water body, and are defined for 3 TraC zones: hydrodynamic; intertidal; and subtidal.

The MCLs tabulated below were trialled by Scotland and Ireland during the development of TraC-MImAS and were found to be consistent with professional opinion in approximately 85% of cases (SEPA will be publishing a final report detailing all trial results). Following these trials and the subsequent technical review (A. Edwards, 2007), the sensitivities of some pressures were reviewed and refined where required. All MCLs should be subject to review as new evidence (monitoring and research) becomes available.

Table 5.9: TraC Morphological Condition Limits (as proposed by SEPA to UKTAG 2007)

Zone	HIGH/GOOD	GOOD/MOD	MOD/POOR	POOR/BAD
	System Capacity Used (%)			
Hydrodynamics	5%	15%	30%	45%
Inter-tidal Zone	5%	15%	30%	45%
Sub-tidal Zone	5%	15%	30%	45%

These capacity limits are not water body type specific. The differences in response between water body types to pressures are accounted for in the scoring system outlined above.

Table 5.9 shows common MCLs for all three water body zones. It is important to emphasis that the MCLs represent percentage capacity used and not the percentage areal coverage of a pressure (development or activity), i.e. the impact ratings of pressures for each of the three zones are weighted differently to reflect the sensitivity of a zone (intertidal being the most sensitive and subtidal the least sensitive).

Within TraC-MImAS the risk of a water body failing the WFD objective of Good and High Ecological Status is conveyed by using the status class boundary titles; High, Good, Moderate, Poor, and Bad. TraC-MImAS uses the MCLs to help quantify the potential risk that a new morphological alteration could impair achievement of the ecological objectives of the WFD (for use in regulation).

As noted above, the impact ratings within TraC-MImAS have been generated using professional judgement and should be subject to further development. However, the framework underpinning TraC-MImAS is considered sound and should be used as the basis for developing further research and development work to provide empirical validation/calibration of the professional judgement values and/or assumptions applied in the tool. This is the long term intention of SEPA for TraC-MImAS, and work has already commenced for the Rivers-MImAS.

At a recent UK and Ireland MTT meeting (November 2007), attendees agreed the following points in relation to the use of TraC-MImAS:

- The group was comfortable that the principles and approach underpinning TraC-MImAS are logical and reasonable;
- TraC-MImAS is suitable to support the three purposes defined by SEPA:
    - Regulatory risk assessments
    - Identification of high status conditions for morphology
    - Contribute to surrogate classification assessments for the other ecological status boundaries (but not to be used in isolation)
- The condition limits proposed are set at an acceptable level for incorporation into the UKTAG Environmental Standards report; however, these values should be reviewed and refined where possible.

5.3 Pressures

The initial risk assessments and resulting risk characterisations were primarily based on the location of pressures and information relating to the 'intensity' of pressures was not reviewed in detail.

Following an initial review of the pressures potentially impacting on the morphology of TraC waters, it was concluded by Chapter 6 of the Literature Review (Appendix 2-1) that the most appropriate method of identifying the intensity of a pressure involved the subdivision of the primary pressure types into more defined activities to allow the resultant changes in environmental factors (morphological attributes) to be investigated. This is reflected within the structure of TraC-MImAS, i.e. to enable some form of generic assessment of the sensitivity of coastal morphology and ecology, primary and secondary pressures have been defined, for example, the subdivision of dredging into 'low' and 'high' impact categories to help represent pressure frequency and extent, and similar definition of shoreline reinforcement representing differences in pressure intensity.

Those pressures agreed for assessment of Irish TraC water bodies for the purpose of further characterisation using TraC-MImAS are outlined in Table 2.1 of Chapter 2. The physical characteristics of the identified pressures and how these were assessed for the purpose of characterisation are detailed in Chapter 3. It is important to note that these pressure definitions still remain in draft form. They were proposed on development of TraC-MImAS then further refined on completion of trials undertaken across Scotland and Ireland. Therefore, future application of TraC-MImAS will undoubtedly identify further refinements that will benefit the future development of this tool. The matrices development by ***MarLIN*** and SensMap when linking similar pressures to environmental factors were outlined above in Tables 5.2 - 5.3, and although these matrices do not detail the probable scale of impact, the links identified are considered consistent with those made within TraC-MImAS.

The sections below briefly outline the relationship between the pressures and potential resultant impacts on ecology and morphology. The likelihood of impacts on the eco-geomorphic attributes is tabulated for each pressure (Tables 5.10 – 5.17.)

5.3.1 Land Claim & Tidal Realignment

Land Claim is defined as follows:

- **Land claim - High impact:** Recent or proposed enclosure of intertidal or subtidal areas within impermeable banks followed by infilling for use by agriculture, housing, port development or industry. Also used for land claim that has taken place in the past and is still deemed to be having a significant impact.
- **Land claim - Low impact:** Historic (e.g. >50yrs ago) enclosure of intertidal or subtidal areas within impermeable banks followed by infilling for use by agriculture, housing, port development or industry. Can also be used for more recent land claim where the impacts are minimal or where the surrounding environment has partly recovered natural habitats and features.

The reclamation of any area of seabed has a direct impact on the biological integrity of the existing habitats. Particularly, a reduction in intertidal area can reduce the carrying capacity of existing habitats such as those associated with feeding grounds for invertebrates, fish, and / or birds. Reclamation can be associated with additional pressures related to the use of this new land such as intensive vessel movements. Further to the definition of high and low impact land claim, the impact of reclamation on TraC tidal zones is weighted differently by TraC-MImAS to reflect the increased pressure likely on intertidal zones relative to that likely within the subtidal zones.

In addition to the direct removal of habitat, this new area of land also has the potential to disrupt/alter coastal processes and natural sediment dynamics, as well as altering bathymetry.

Table 5.10: Likelihood of the pressure 'Land Claim' resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4 (2007))

Eco-geomorphic Attributes	Land Claim - Low Impact	Land Claim - High Impact
Hydrodynamics		
Tidal Range	**Moderate**	**High**
Currents	**Moderate**	**High**
Waves	**Moderate**	**High**
Flushing/exchange	**Moderate**	**High**
Salinity/mixing/stratification	**Moderate**	**High**
Freshwater Flow	**Low**	**Low**
Intertidal Zone		
Planform	**High**	**High**
Profile (lateral)	**High**	**High**
Nature and extent of coastal features	**Moderate**	**High**
Natural sediment size range	**Moderate**	**Moderate**
Longitudinal sediment transport processes	**Moderate**	**High**
Lateral sediment transport processes	**Moderate**	**High**
Subtidal Zone		
Planform	**High**	**High**
Profile	**High**	**High**
Nature and extent of coastal features	**Moderate**	**High**
Natural sediment size range	**Moderate**	**Moderate**
Longitudinal sediment transport processes	**Moderate**	**High**
Lateral sediment transport processes	**Moderate**	**Moderate**

5.3.2 Dredging, Other Disturbances to Seabed, & Disposal at Sea

Dredging is considered to be one of the most significant pressures on morphology, particularly in HMWBs containing important infrastructure such as ports. Dredging and disposal activities primarily increase turbidity/suspended sediment and deposition, which can potentially influence primary productivity by phytoplankton and the growth and survival of benthic species. Depending on the type of dredging activity, the bathymetry of a water body can be significantly altered, with aggregate dredging posing the most risk.

A significant impact of disposal at sea is considered to be that associated with the likely change in natural sediment size range. Disposal also has the direct impact of smothering existing floral and faunal habitats, and can alter bathymetry of the disposal site.
On assessing the ecological effect of dumping dredged sediments, Essink (1999) recognised impaired growth of filter feeding organisms, deriving thresholds for

smothering by deposits of one to two centimetres for these organisms. Other, more mobile macrozoobenthos were found to survive burial of 20-30cm, as they were able to migrate back to the surface (a process that took 1-2 weeks). Phytoplankton are sensitive to light penetration, which is strongly impeded by suspended sediments. Impacts of restricted light were found to be local and restricted in time, and are unlikely to always be significant at the water body scale (depending on the scale and frequency of dredging). Increased turbidity was also found to impair the growth of angiosperms such as eelgrass. Some fish avoid turbid water, and enhanced suspended matter is unfavourable to young herring and smelt, but this is difficult to generalise.

TraC-MImAS does not specifically consider suspended solids and turbidity as impacts on ecology; however, these can be related to the eco-geomorphic attribute 'natural sediment size range'.

Sedimentation brought about by the dredging and deposition of material was found to have varied impacts by Essink (1999). On intertidal flats, microphytobenthos species were found to be well adapted to natural re-working of sediment by waves and currents, however little information was sourced relating to the impacts on plants, although it is concluded that the stability of intertidal sediments plays an important role in the establishment and maintenance of sea grasses. Sessile (non-moving) species generally had a low tolerance to increased sedimentation, while motile species had more varied tolerance, often dependent on the substrate type. A change from predominantly soft sediments to hard substrates as a result of decreased sedimentation would introduce different communities, for example the development of rocky shore communities. Frequent, short disturbances (perhaps one or two per year), were found to have a similar impact to less frequent dredging in larger quantities, as less time was available for sediments to redistribute and species to recover.

Aggregate dredging within Ireland is currently not an active pressure. However, recent research undertaken in Irish waters, such as that associated with the Irish Sea Marine Aggregates Initiative (IMAGIN) will provide information to inform policy generation in this field. This pressure is likely to impact on off-shore waters, outside the WFD delineated water bodies. If most aggregate extraction is concentrated in offshore areas, adverse impacts on coastal process are likely to be limited, but impacts can include losses of species diversity, population density and biomass of benthic invertebrates in dredged areas.

The assessment of the potential impacts that dredging activities may impose on the morphology of TraC waters was considered using the following pressure types:

- **Low impact dredging:** within the Marine Morphology Study this pressure is associated with maintenance dredging for purposes of navigation as identified using the extents of shipping navigation channels, and also that associated with OPW/Local Authority channel drainage schemes of TraC water bodies and connected upstream waters
- **High impact dredging:** this was associated with identified capital dredging and is also a suitable pressure definition for aggregate dredging. However, as aggregate dredging can permanently change seabed bathymetry and significantly alter bed ecology, the impact rating defined in TraC-MImAS may need to be increased.
- **Other Disturbances to Seabed:** In addition to the presence of marine cables and pipes; this pressure type was used to define commercial dredging for shellfish

As noted above, Module 4 (impact assessment) of TraC-MImAS estimates both the intensity (likelihood) and extent of impact (zone of impact). However, during a peer review of TraC-MImAS. A. Edwards (2007) noted that the extent of impact can vary between attributes "***e.g. dredging will affect fine sediments over an area that is large relative to the dredged-out cavity***". In the cavity benthos can be destroyed, whereas outside of this the rate of fine deposition is only increased.

To assist in compliance of Arterial Drainage Maintenance operations with the European Communities (Natural Habitat) Regulations 1997, the OPW have completed a series of ecological impact assessments of the effects of statutory arterial drainage maintenance activities on Natura 2000 sites (including raised bogs, atlantic salmon, otter, floating river vegetation and fresh water pearl mussel).

It is evident from the data review that channels maintained by OPW and local authorities are of limited extent within TraC waters. This is confirmed by OPW (2007); "Normally none or limited maintenance is required in tidal areas". However, the boundaries of some TraC water bodies, reaching to river-like tidal channels are defined by the alterations of the original Drainage Scheme embankments and channels, which "are maintained at status quo" (OPW, 2007).

Within the series of ecological impact assessments, OPW define the differences between the construction and maintenance of Arterial Drainage Schemes.

- Construction of the original schemes required major hard engineering and typically involved widening and deepening of existing channels. Of potential relevance to downstream TraC waters; arterial drained channels have 'significantly more uniform flow velocities and a reduction in connectivity to floodplains'.
- Maintenance works are undertaken using environmental work practices to minimise ecological disturbance. Work generally consists of the removal of silt and vegetation, repairing bank damage or slippage and removal of obstructions such as trees encroaching at low levels on the banks. No excavation of virgin ground is required and generally the majority of the riparian vegetation is left intact.

To reflect this, the attributes impacted on by 'Dredging – Low Impact' were used to estimate the overall impacts of drainage channel maintenance on TraC waters.

Table 5.11: Likelihood of the pressures Dredging – High & Low Impact, Other Alterations to Seabed, and Sea Disposal, resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4 (2007))

Eco-geomorphic Attributes	Dredging - High Impact	Dredging - Low Impact	Other alterations to bed or substrate	Sea Disposal
Hydrodynamics				
Tidal Range	Low	Low	Low	Low
Currents	Moderate	Moderate	Moderate	Moderate
Waves	Low	Low	Low	Low
Flushing/exchange	Low	Low	Low	Low
Salinity/mixing/stratification	Low	Low	Low	Low
Freshwater Flow	Low	Low	Low	Low
Intertidal Zone				
Planform	Low	Low	Low	Low
Profile (lateral)	High	Moderate	Low	Moderate
Nature and extent of coastal features	High	Moderate	Moderate	Moderate
Natural sediment size range	High	Moderate	Moderate	High
Longitudinal sediment transport processes	High	Moderate	Moderate	Moderate
Lateral sediment transport processes	High	Moderate	Moderate	Moderate
Subtidal Zone				
Planform	Low	Low	Low	Low
Profile	High	Moderate	Low	Moderate
Nature and extent of coastal features	High	Moderate	Moderate	Moderate
Natural sediment size range	High	Moderate	Moderate	High
Longitudinal sediment transport processes	High	Moderate	Moderate	Moderate
Lateral sediment transport processes	High	Moderate	Moderate	Moderate

For the purpose of this study 'Other Disturbances to Seabed' represents ferry movements, licensed shellfish dredging areas, pipelines and cables, and wind farms.

This pressures type is defined by the SEPA MImAS study as "any other temporary disturbances to bed morphology or substrate character where the impacts are likely to be restricted to the area of bed directly disturbed and where the bed is likely to recover significantly over time".

As noted in Chapter 3, it is assumed that areas zoned for wind farms are currently undergoing investigative surveying prior to development. However, on development of these sites, the pressure on the water bodies containing these sites may be increased to account for potential impacts such as seabed area loss due to the footprint of turbine foundations (similar impacts associated with land claim), scouring, erosion and sedimentation of the seabed (dredging high/low impact) and cables and traffic. The potential ecological effects of off-shore wind farms are discussed in Hiscock ***et al*** (2002). The extent of licensed aquaculture sites were mapped and reviewed as a component of this pressure (estimated areas dredged for shellfish). However, detailed assessment of aquaculture is outside the scope of this study.

5.3.3 Piled Structures

TraC-MImAS addresses this pressure in the form of total area covered by the structure and not the footprint of the individual piles. Alternative footprints were assessed during the trials of TraC-MImAS, e.g. sum of the area of individual piles supporting a structure, but these proved difficult to use due to the lack of oblique coastal imagery and field trials to confirm the number and extent of piles. This method resulted in the estimation of many structures footprints in the trials, and was concluded as an inappropriate method of assessment and was therefore revised.

The technical review of TraC-MImAS found that the overall scour effects of piled structures are greater if the piles are close together (A. Edwards, 2007). This indicates that TraC-MImAS would benefit from a more refined pressure footprint for piled structures. I order to do this detailed coastal images or field trials would be required.

The construction of piled structures, such as bridges, can result in the direct loss of habitat at the footprints of the piles, whilst there presence has the potential to alter estuarine processes and natural sediment dynamics depending on the size and number of piles.

Table 5.12: Likelihood of the pressure 'Piled Structures' resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4(2007))

Eco-geomorphic Attributes	Piled Structures
Hydrodynamics	
Tidal Range	**Low**
Currents	**Moderate**
Waves	**Moderate**
Flushing/exchange	**Low**
Salinity/mixing/stratification	**Low**
Freshwater Flow	**Low**
Intertidal Zone	
Planform	**Moderate**
Profile (lateral)	**Moderate**
Nature and extent of coastal features	**Moderate**
Natural sediment size range	**Moderate**
Longitudinal sediment transport processes	**Moderate**
Lateral sediment transport processes	**Moderate**
Subtidal Zone	
Planform	**Moderate**
Profile	**Moderate**
Nature and extent of coastal features	**Moderate**
Natural sediment size range	**Moderate**
Longitudinal sediment transport processes	**Moderate**
Lateral sediment transport processes	**Moderate**

5.3.4 Flow and Sediment Manipulation Structures

Flow and sediment manipulation structures are defined for the assessment within TraC-MImAS as 'hard engineering structures built to stabilise waterways for navigation and to counter the effects of longshore drift' such as piers, groynes and training walls.

Table 5.13: Likelihood of the pressure 'Flow and Sediment Manipulation Structures' resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4 (2007))

Eco-geomorphic Attributes	Flow and Sediment Manipulation
Hydrodynamics	
Tidal Range	**Low**
Currents	**Moderate**
Waves	**Low**
Flushing/exchange	**Low**
Salinity/mixing/stratification	**Low**
Freshwater Flow	**Low**
Intertidal Zone	
Planform	**Low**
Profile (lateral)	**Moderate**
Nature and extent of coastal features	**Moderate**
Natural sediment size range	**Moderate**
Longitudinal sediment transport processes	**Moderate**
Lateral sediment transport processes	**Moderate**
Subtidal Zone	
Planform	**Low**
Profile	**Moderate**
Nature and extent of coastal features	**Moderate**
Natural sediment size range	**Moderate**
Longitudinal sediment transport processes	**Moderate**
Lateral sediment transport processes	**Moderate**

These structures have the potential to disrupt tidal flow and interaction, alter estuarine processes and natural sediment dynamics. The construction of piers and slipways etc can result in direct habitat loss at the footprint of the structure.

5.3.5 Impounding Structures & Causeways

These are defined as follows:

- **Impounding Structures:** A temporary or permanent structure that extends across a channel that is used to impound, measure or alter flow (e.g. weirs, sluices).
- **Causeways:** A physical barrier projecting from the shore whose foundations extend to the bed and where gaps in the foundings represent <20% of the total length. Typically used to support transport routes.

TraC-MImAS differentiates between these pressures by assigning a lower value in the impact assessment of Causeways to indicate that the 'likelihood' that Causeways will result in an impact on an eco-geomorphic attribute is less than that of impoundments. The only exception to this is for waves; both pressures are considered very likely to result in an impact on waves. This distribution of impact was queried by the Marine Morphology Steering Group, who noted that Causeways may have a more significant impact than 'moderate'.

Table 5.14: Likelihood of Impoundments resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4 (2007))

Eco-geomorphic Attributes	Impounding Structures	Causeways
Hydrodynamics		
Tidal Range	**High**	**Moderate**
Currents	**High**	**Moderate**
Waves	**High**	**High**
Flushing/exchange	**High**	**Moderate**
Salinity/mixing/stratification	**High**	**Moderate**
Freshwater Flow	**High**	**Moderate**
Intertidal Zone		
Planform	**High**	**Moderate**
Profile (lateral)	**High**	**Moderate**
Nature and extent of coastal features	**High**	**Moderate**
Natural sediment size range	**High**	**Moderate**
Longitudinal sediment transport processes	**High**	**Moderate**
Lateral sediment transport processes	**High**	**Moderate**
Subtidal Zone		
Planform	**High**	**Moderate**
Profile	**High**	**Moderate**
Nature and extent of coastal features	**High**	**Moderate**
Natural sediment size range	**High**	**Moderate**
Longitudinal sediment transport processes	**High**	**Moderate**
Lateral sediment transport processes	**High**	**Moderate**

As noted in Chapter 3 of this report, the footprint for impounding structures was unconfirmed by the TraC-MImAS development team (SEPA) at the time of writing. The most recent assessment method considered the proportion of the assessment area impounded, for example, if a water body was impounded for less than 25% of its area, a footprint score of 5 is entered to TraC-MImAS. These scores were not trialled sufficiently and at present all footprint scores result in a risk to the achievement of any status class. To progress the assessment of impoundments within Irish TraC waters, the following table was presented to the Marine Morphology Steering Group for discussion.

Table 5.15: Summary of thresholds and footprints proposed or used for the assessment of impoundments

Initial Risk Assessments (2004 - 2005)					
Irish Thresholds		***2b - Not at Risk***	***2a - Probably Not at Risk***	***1b - Probably at Risk***	***1a - At Risk***
		No impoundment			Impoundment present
UK-TAG Thresholds		***High/Good Boundary***	***Good/Moderate Boundary***		***Identification of provisional HMWB***
		Main channel free of impoundments, if tributary channels impounded, <5% of water body area affected, no critical areas affected	Main channel free of impoundments, if tributary channels impounded <10% area affected, no critical areas affected		
		<5% of intertidal areas lost due to raised water levels upstream of impoundments in tributaries	<15% of intertidal areas lost due to raised water levels upstream of impoundments in tributaries		
TraC-MImAS (2007)					
SEPA (proportion of assessment area impounded)	Impoundment	No impoundment	<25% (footprint = 5)		
			25-50% (footprint = 10)		
			>50% (footprint = 25)		
	Semi-permeable barrier	<25% (footprint = 0)	<25% (footprint = 5)		
			25-50% (footprint = 10)		
TraC-MImAS Technical Review (A.Edwards, 2007)		Ratio of impoundment entrance area to impounded surface area			

Table 5.15 summarises the thresholds/footprints used or proposed for the assessment of impounding structures. It was agreed that the definitions provided by UKTAG for the initial risk assessments were useful, but that defined by A. Edwards (2007) was most appropriate for the assessment of impounding structures, but more suited to freshwater impoundments. For the purpose of this study it was agreed that the area impounded, i.e. not expressed as a ratio, was most suitable for the assessment of areal pressure footprints within TraC-MImAS.

Within the TraC-MImAS definition of impounding structures are sluices. The assessment of these structures using the above footprint is not possible, in many cases as sluices are generally associated with embankment schemes and therefore a backup to drainage channels, or with lagoons. It was agreed that where identified, these structures should be reported on separately to the results of TraC-MImAS. For example, the following sluices are reported in Chapter 6 of this report but not assessed within TraC-MImAS:

- Swilly Estuary - has an extensive network sluices associated with the 23km of embankments identified
- Blanket Nook Lough - the flow exchange between this lagoon and Swilly estuary occurs via a sluice.

The presence of impounding structures such as barrages, causeways and sluices can alter the bathymetry in a water body, disrupt tidal flow and interaction, and alter natural sediment dynamics via loss of continuity. Impacts to ecology can include destruction and alteration of benthic habitats, loss of faunal nursery, refuge and feeding areas, as well as disruption of habitat connectivity/continuity such as fish population movements.

5.3.6 Shoreline Reinforcement

Hard shoreline defences such as sea walls fix the coastline to its position at the time of construction restricting it from naturally migrating landward or seaward in response to sea level rise, wave action etc.

Protection or defence of a shoreline can disrupt beach/dune interactions, restrict or prevent sediment inputs to the sediment budget, and more significantly, restrict the shoreline's ability to respond to sea level changes (coastal squeeze).

TraC-MImAS considers two forms of shoreline reinforcement; **high** and **low impact**. This allows the distinction between those structures which have persistent influence over the intertidal or subtidal zones such as sea walls, sheet piling and revetments, and those of 'softer' material or 'set back' with less influence on the water body.

Within TraC-MImAS, the likelihood that the following morphological attributes will be impacted by shoreline reinforcement is higher for persistent, hard engineering type structures (high impact):

- **Waves** – less persistent, or 'softer' reinforcement is less likely to restrict wave impact on the shore.
- **Nature and extent of coastal features** – the restriction of wave impact on a shoreline via the use of hard coastal structures can reduce the natural erosion/deposition of a shore.
- **Longitudinal sediment transport processes of the intertidal zone** – the restriction of waves breaking at the shore can in turn reduce the transport of material parallel to the shore (littoral drift).
- **Lateral sediment transport processes within the subtidal** – restriction of sediment input from processes such as littoral drift and shoreline erosion can impact on this sediment transport process.

Ecological impacts potentially resulting from such alterations to morphological attributes and processes include disruption to natural habitats, loss of faunal nursery, refuge and feeding areas.

Table 5.16: Likelihood of the pressure 'Shoreline Reinforcement' (High & Low Impact) resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4 (2007))

Eco-geomorphic Attributes	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact
Hydrodynamics		
Tidal Range	**Low**	**Low**
Currents	**Low**	**Low**
Waves	**Moderate**	**Low**
Flushing/exchange	**Low**	**Low**
Salinity/mixing/stratification	**Low**	**Low**
Freshwater Flow	**Low**	**Low**
Intertidal Zone		
Planform	**Low**	**Low**
Profile (lateral)	**Low**	**Low**
Nature and extent of coastal features	**Moderate**	**Low**
Natural sediment size range	**Moderate**	**Moderate**
Longitudinal sediment transport processes	**Moderate**	**Low**
Lateral sediment transport processes	**Moderate**	**Moderate**
Subtidal Zone		
Planform	**Low**	**Low**
Profile	**Moderate**	**Moderate**
Nature and extent of coastal features	**Moderate**	**Low**
Natural sediment size range	**Moderate**	**Moderate**
Longitudinal sediment transport processes	**Moderate**	**Moderate**
Lateral sediment transport processes	**Moderate**	**Low**

5.3.7 Flood Embankment

Flood embankments, similarly to shoreline reinforcement can restrict landward movement and potentially result in coastal squeeze. The restriction of flow to flood areas behind embankments can adversely impact on the condition of estuarine marsh where present i.e. impact on the nature and extent of coastal features. A reduction in sediment supply to an embanked water body can alter the morphology of that water body's intertidal and subtidal zone.

Table 5.17: Likelihood of the pressure 'Embankments' resulting in an impact on the defined eco-geomorphic attributes (extract from SEPA version a4 (2007))

Eco-geomorphic Attributes	Flood Defence Embankment
Hydrodynamics	
Tidal Range	**Low**
Currents	**Low**
Waves	**Low**
Flushing/exchange	**Low**
Salinity/mixing/stratification	**Low**
Freshwater Flow	**Low**
Intertidal Zone	
Planform	**Low**
Profile (lateral)	**Low**
Nature and extent of coastal features	**Moderate**
Natural sediment size range	**Low**
Longitudinal sediment transport processes	**Low**
Lateral sediment transport processes	**Moderate**
Subtidal Zone	
Planform	**Low**
Profile	**Low**
Nature and extent of coastal features	**Moderate**
Natural sediment size range	**Low**
Longitudinal sediment transport processes	**Low**
Lateral sediment transport processes	**Moderate**

5.3.8 Intensive Land Use

Assessing intensive land use quantitatively as a single pressure on marine morphology is complex. As noted in Chapter 3, a land use category inherently 'contains' many of the more specific and distinct pressures that have been identified and reviewed in more detail throughout this study. For example, the pressure of 'Land Claim' can be related to urban and industrial use, development of port infrastructure, and also to agriculture (usually historically) such as enclosure for grazing or arable production. Such pressures arise as a result of land use change acting as a 'driver'. Another specific pressure identified as associated with 'intensive use' in Ireland but not directly accounted for by the current version of TraC-MImAS is that of saltmarsh grazing.

The identification of the impacts that result from these intensive use pressures has proved difficult for the following reasons:

- Difficulties determining whether the impact results from a land use pressure at the shoreline or from further upstream in the water body (for example increased sediment delivery associated with wider catchment inputs such as run off from agricultural land or forestry). A good deal of scientific/theoretical information is available on the impacts of agricultural intensification in the uplands on river morphology and flow, but much less for estuarine and coastal environments;

- That the 'intensive use' today often results from a historical change in use up to hundreds' of years ago, resulting in legacy impacts;
- Much 'scientific' information relates to the water quality impacts of pollution resulting from land use, rather than morphological impacts;
- Current paucity of data to permit a comprehensive and consistent assessment of the pressure to all water bodies, e.g. more data is available for designated sites such as SACs.

Links between 'intensive use' and other pressures identified in this study

This issue is well illustrated by an example of the Shannon Estuary given by Healy and Hickey (2002), where approximately 6,500ha of the estuary lowlands have been reclaimed for agriculture and other purposes. Urban development and port and harbour infrastructure have had significant impacts on this estuary. Early reclamation enclosed salt marshes and mudflats with earth banks for agricultural purposes (details of which are quantified for assessment with TraC-MImAS). More recently, reclamation for industrial, commercial and recreational uses has taken place, as well as works for suburban expansion and housing development with associated embankments and revetments as flood protection devices. The 'footprints' of these pressures have been digitised for these areas in the form of 'land claim', 'flow and sediment manipulation' structures, and shoreline reinforcement. Pasture and marsh/saltmarshes have been partially drained, using channels leading to flap sluices and other outlets to artificial drainage channels and tidal creeks (the presence and maintenance of such drainage channels is quantified using estimated footprints of low impact dredging for assessment within TraC-MImAS). Further dredging of the shipping channel through the estuary was envisaged by Healy and Hickey (2002), as well as large-scale infrastructural developments. The maintenance of this tidal channel has been quantified using the footprint of the shipping channel as an indication of maintenance dredging.

The table below summarises the association of specific pressures assessed within this study with land cover types identified by the EPA CORINE 2000 land cover dataset.

Table 5.18: Matching TraC-MImAS pressures with intensive land use and land cover data

			Associated pressures (assessed independently within TraC-MImAS)									
CORINE (2000) land cover class		Initial Risk Assessment 'Intensive use'	Land Claim	Tidal channel realignment	Dredging	Disposal at Sea	Piled structures	Flow & sediment manipulation structures	Impounding structures	Causeways	Shoreline reinforcement	Flood defence embankment
111	Continuous urban fabric	Urban fabric	√	√	√		√	√	√	√	√	√
112	Discontinuous urban fabric											
133	Construction sites											
141	Green urban areas											
142	Sport and leisure facilities											
121	Industrial and commercial units	Industrial, commercial, transport	√	√	√	√	√	√	√	√	√	√
122	Road and rail networks and associated land											
123	Sea Ports											
124	Airports											
131	Mineral extraction sites											
132	Dump											
211	Non-irrigated arable land	Arable	√						√		√	√
241	Annual crops associated with permanent crops											
244	Agro-forestry	Coniferous forest	√									
312	Coniferous forests											

5.3.8.1 Salt Marsh Grazing

Reclamation, drainage and overgrazing have led to a marked depletion in the number of saltmarshes in Ireland, indicating that their conservation is an urgent requirement (Curtis & Skeffington, 1998).

Following land claim/enclosure, saltmarshes were historically used for grazing domestic stock. This was considered a traditional use of the land, without ploughing or agrochemicals, and created habitats of wildlife interest (grazing marsh). When unimproved permanent pasture is used for low intensity grazing, it often develops a vegetation structure attractive to nesting birds. Rare species of plants are often found in association with pasture and the brackish water drainage ditches, the latter being particularly important for a number of rare invertebrates. More recently, these semi-natural habitats have in some cases been claimed for intensive agriculture.

Grazing can still occur extensively on marshes and has a major effect on the structure and species composition of a marsh (e.g. through the grazing process itself and also soil compaction and poaching/trampling by animals). In general, as grazing intensity increases, there is a loss of structural and species diversity. Several levels of grazing, with different levels of impact, can be defined:

Light	most of the standing crop is not removed
Moderate	maximum standing crop almost completely removed
Heavy	height <10 cm, all standing crop removed
Abandoned	matted vegetation, no standing crop removed.

The intensity of grazing of saltmarsh can be estimated by matching livestock density reported by the Central Statistics Office (CSO) with the saltmarsh areas defined by the EPA CORINE 2000 dataset. A study titled ‘Visual Environmental Data on Soils and Landuse’ publish by Teagasc in 1999 included information and maps on the total stocking density of livestock across Ireland, using information obtained from the 1991 Agricultural Census which report density per District Electoral Division, and therefore easily mapped. However, the most recent Agricultural Census (2000) only provides livestock data per county and excludes the land types marsh, bog and unused rough grazing. These limitations prevented the identification of grazed saltmarsh areas neighboring TraC waters.

The NPWS are currently undertaking a review of Ireland's saltmarsh, with the aim to map all areas identified. It was agreed with the Marine Morphology Steering Group that on completion of this NPWS study the mapped saltmarsh extents should be compared with the outputs of this study, and more detailed census of livestock density.

5.3.8.2 Peat Bogs

The initial risk assessments completed in 2005 identified a strong correlation between mapped Bord na Mona peat extraction areas and CORINE information, therefore, CORINE data was used in this assessment.

Exploitation and severe over-grazing of bog can result in extensive loss of plant cover which in turn can lead to erosion of the surface peat by wind and rain. However, changes in the management of agricultural and peat lands over the past decade has introduced supportive measures (as outlined below) that have reduced impacts on TraC waters from exploitation of peat bogs. These pressures are therefore not considered significant for the morphological quality of Ireland's TraC waters.

A conference titled 'The state of biological diversity in the European Union' held in May 2004 reported that wetlands cover 16% of the surface of Ireland and peat-bogs represent 95% of this total. The main peat-bog areas are concentrated in the West and North West of Ireland. In addition to land disturbance associated with exploited bogs, these areas are drained to facilitate cutting. Once the land is drained, it is suitable for other purposes such as coniferous forests. The conversion of peat-bogs to transitional shrub land as a result of drainage is also common. This change in land use can contribute to the pressures on wetland ecosystems.

The introduction of the EU Headage Payment Scheme led to large increases in sheep numbers with a near "three-fold increase nationally since 1980" (MacGowan, 2002). Several studies have reported the impact of over grazing, but generally focus on lakes and rivers. The loss of plant cover leads to the erosion of peat (down to the mineral soil in some places) which are known to result in the siltation and acidification of lakes, which in turn impacts on spawning beds of salmon and trout. It can be assumed therefore, that similar impacts were likely of estuaries and lagoons bordering such lands. However, in 1994 the voluntary Rural Environmental Protection Scheme (REPS) was initiated to 'reward farmers for carrying out their farming activities in an environmental friendly manner and to bring about environmental improvement on existing farms'. This scheme has gone some way in reducing over grazing of peat bogs. However, arable and intensive grassland are not recognised as REPS habitats.

Recent research by Teagasc involves 16 projects focused primarily on research strategies to reduce pollution from agriculture. This indicates that the current practices surrounding agriculture and peat-bogs do not severely impact on the morphology of transitional and coastal waters and are more significant to the degradation of water quality.

Many raised and blanket bogs are designated Special Areas of Conservation or proposed Natural Heritage Areas, and under REPS peat lands are protected from their main threats of land improvement (turf cutting and afforestation), and sustainable grazing is promoted.

In 2003 the Department of Agriculture, Food and Rural Development (DARD) published Commonage Framework plans in agreement with the DEHLG. These include grazing regimes for the commonage.

On review of the existing management schemes and statutory protection of sensitive habitats, the impact of agricultural land use is not considered as a significant impact to the morphology of TraC waters. However, this is with the exception of saltmarsh; the further assessment of saltmarsh grazing is recommended on completion of the NPWS study to help quantify the extent of intensive grazing of these habitats.

5.3.8.3 Intensive Sea Use

In addition to the range of intensive land uses at the margins of estuarine and coastal areas, the sea itself is subject to increasing human activities and uses. Where these uses involve building structures or dredging, the pressure will be assessed as appropriate using TraC-MImAS. The types of activity that could result in morphological pressures include:

- Aggregate extraction or navigation dredging;
- Deposition of waste/dredgings at sea;
- Cable and pipe laying;

- Energy projects including marine wind turbine generators, wave energy generators and tidal barrages;
- Marine aquaculture and fishing
- Shipping

The morphological impacts associated with these pressures are discussed above. Although highly site and activity specific, the potential impacts could be generically summarised to include: substrate removal; scour and alteration of bed topography; altered turbidity/light levels; sediment mobilisation and plumes; re-suspension and smothering by fine sediment.

The most significant intensive sea use within Ireland is that of aquaculture, with licensed areas occupying approximately 17 % (2548km^2) of the TraC water body area, 15084km^2. Detailed assessment of the impact of aquaculture practices is outside the scope of this study (refer to Chapter 2, Section 2.1).

5.4 Development & Use of TraC-MImAS for the Purpose of Risk Assessments

TraC-MImAS uses the concept of system capacity to estimate the risk of a water body failing to meet WFD status classes. The following is an example of how this system estimates this risk using the five modules detailed in Sections 5.2.1 – 5.2.5 above.

5.4.1 Clonakilty Harbour (SW_100_0100)

This water body was characterised by the initial risk assessments as 'probably at risk' from combined sewer and treatment plant overflows, and 'probably not at risk' from point source discharges of waste water treatment plants and intensive land use. Further characterisation of the pressures on this water body and assessment using TraC-MImAS indicate that this water body is at risk of not achieving GES due to physical alterations. If the pressures associated with point source discharges were mitigated with the aim of achieving GES, the results of TraC-MImAS indicate that physical (morphological) alterations in this water body may prevent the attainment of GES.

Module 1 – Attribute Module & Module 2 – Typology Module

Clonakilty Harbour was classed as a water body type TW2 (polyhaline, mesotidal and sheltered), which when using TraC-MImAS translates to a transitional, meso to macrotidal water body. All eco-geomorphic attributes assessed within TraC-MImAS are considered relevant to this type of water body.

Module 3 – Sensitivity Assessment

Table 5.19 below details the sensitivity values estimated for the ecology and morphology of this type of water body, i.e. transitional meso to macro tidal. The key to this table outlines the meanings of the values assigned.

Table 5.19: Sensitivity values estimated for the ecology and morphology of Clonakilty Harbour (transitional meso – macro tidal water body)

Ecogeomorphic Attributes	Ecological Sensitivity	Morphological Sensitivity - Resistence	Morphological Sensitivity - Resilience	Morphological Sensitivity (Min of Resistance & Resilience)
Hydrodynamics				
Open Water				
Tidal Range	**0.5**	0.5	0.5	**0.5**
Currents	**0.5**	0.5	0.5	**0.5**
Waves	**0.5**	0.5	0.5	**0.5**
Freshwater Influence				
Flushing/exchange	**0.5**	0.5	0.5	**0.5**
Salinity/mixing/stratification	**0.5**	0.5	0.5	**0.5**
Freshwater Flow	**0.5**	0.5	0.5	**0.5**
Intertidal Zone				
Geometry				
Planform	**1.0**	1	1	**1.0**
Profile	**0.5**	0.5	0.5	**0.5**
Morphological features & substrate				
Nature and extent of coastal features	**1.0**	0.5	0.5	**0.5**
Natural sediment size range	**0.5**	0.5	0.5	**0.5**
Continuity and sediment supply				
Longitudinal sediment transport processes	**0.5**	0.5	0.5	**0.5**
Lateral sediment transport processes	**0.5**	1	0.5	**0.5**
Subtidal Zone				
Geometry				
Planform	**1.0**	1	1	**1.0**
Profile	**0.5**	0.5	0.5	**0.5**
Morphological features & substrate				
Nature and extent of coastal features	**1.0**	0.5	0.5	**0.5**
Natural sediment size range	**0.5**	0.5	0	**0**
Continuity and sediment supply				
Longitudinal sediment transport processes	**0.5**	1	0	**0**
Lateral sediment transport processes	**0.5**	0.5	0	**0**
KEY:				
0	Insensitive	System/feature unlikely to respond to disturbance	System/feature will likely recover to a pre-disturbance state or dynamic	Insensitive
0.5	Sensitive	System/feature will potentially respond to disturbance	System/feature will potentially recover to a pre-disturbance state or dynamic	Sensitive
1	Highly Sensitive	System/feature likely to respond to disturbance	System/feature unlikely to recover to a pre-disturbance state or dynamic	Highly Sensitive

The morphological features of least sensitivity in this type of water body are subtidal natural sediment size range, longitudinal and lateral sediment transport. It is considered that although these features are likely to respond to disturbance, they are resilient and likely to recover. The morphological attribute considered most sensitive is planform. A change to the spatial extent and / or intertidal zone as a result of prevailing coastal processes or realignment of the high water mark due to physical alterations (pressures) is considered difficult to resist in such a water body, and changes to these attributes are likely to prevent recovery to a pre-disturbed state/dynamic.

Module 4 – Impact Assessment (Pressure) Module

Now that the sensitivity of changes to the morphological attributes relevant to a meso to macrotidal transitional water body such as Clonakilty Harbour is estimated, the 'likelihood' that pressures will have an impact on these attributes can be determined (see table 5.20).

The physical alterations (pressures) identified for Clonakilty Harbour are listed below, and Table 5.21 shows how these pressures are distributed between the intertidal and subtidal zones.

- High impact land claim
- Structures that manipulate flow / sediment – non-piled piers and slipway
- High impact shoreline reinforcement – associated with the harbour and surrounding roads
- Embankments

The following key is used to estimate the likelihood of these pressures impacting the attributes relevant to this water body:

1 In most cases, this activity will result in an impact on a eco-geomorphic attribute

0.5 In some cases, this activity will result in an impact on a eco-geomorphic attribute

0 In most cases, this activity will not result in an impact on a eco-geomorphic attribute

Table 5.20: Likelihood of pressures identified in Clonakilty Harbour resulting in an impact on the defined attributes

Ecogeomorphic Attributes	Land Claim - High Impact	Flow and Sediment Manipulation Structures	Shoreline Reinforcement - High Impact	Flood Defence Embankment
Hydrodynamics				
Open Water				
Tidal Range	1	0	0	0
Currents	1	0.5	0	0
Waves	1	0	0.5	0
Freshwater Influence				
Flushing/exchange	1	0	0	0
Salinity/mixing/stratification	1	0	0	0
Freshwater Flow	0	0	0	0
Intertidal Zone				
Geometry				
Planform	1	0	0	0
Profile (lateral)	1	0.5	0	0
Morphological features & substrate				
Nature and extent of coastal features	1	0.5	0.5	0.5
Natural sediment size range	0.5	0.5	0.5	0
Continuity and sediment supply				
Longitudinal sediment transport processes	1	0.5	0.5	0
Lateral sediment transport processes	1	0.5	0.5	0.5
Subtidal Zone				
Geometry				
Planform	1	0	0	0
Profile	1	0.5	0.5	0
Morphological features & substrate				
Nature and extent of coastal features	1	0.5	0.5	0.5
Natural sediment size range	0.5	0.5	0.5	0
Continuity and sediment supply				
Longitudinal sediment transport processes	1	0.5	0.5	0
Lateral sediment transport processes	0.5	0.5	0.5	0.5

As discussed in Chapter 3, the extents of pressures are calculated for the intertidal and subtidal zones of a water body, i.e. the pressure 'footprint' (see Table 5.21). The pervasiveness of these pressures to attributes outside this footprint is then identified by estimating its 'zone of impact' (see Table 5.22).

Table 5.21: Pressure footprints identified for Clonakilty Harbour

Pressures		Meso - macro Tidal	
		Location of Activity	
		Intertidal	Subtidal
Land claim- High impact	Area (km^2)	0.030933	0.001091
Land claim- Low impact	Area (km^2)		
Dredging- High Impact	Area (km^2)		
Dredging- Low impact	Area (km^2)		
Other disturbances to seabed	Area (km^2)		
Sea disposal of dredgings	Area (km^2)		
Structure to manipulate flow/sediment	Area (km^2)	0.002029	
Structures with piled supports	Area (km^2)		
Shoreline reinforcement- High impact	Length (km)	5.108	0.07
Shoreline reinforcement- Low impact	Length (km)		
Flood defence embankment	Length (km)	2.01418	
Tidal channel realignment- High Impact	Length (km)		
Tidal channel realignment- Low impact	Length (km)		
Impounding structure	Footprint rules		
Causeway	Length (km)		

Table 5.22: Estimated Zone of Impact for the pressures identified in Clonakilty Harbour

	Zones		
Activity	Hydrodynamics	Structure of the Intertidal	Structure of the Subtidal
Land claim - High Impact	2	2	2
Flow & sediment manipulation	1	1.5	1.5
Shoreline reinforcement - High Impact	1	1	1.5
Embankment	1	1	1

Module 5: Capacity Based Scoring System

Section 5.2.5 above introduced how the output values from the first four modules are used to calculate an impact score for each attribute relevant to the existing pressures within a water body.

Table 5.23 shows how the impact ratings were estimated for 'Shoreline Reinforcement – high impact' in a transitional meso to macro tidal water body type, using the equation below. The impact values for each attribute are first calculated and are then averaged to provide an impact score for each of the three water body zones.

Relevance	X	Ecological Sensitivity	X	Morphological Sensitivity	X	Likelihood of Impact
Output from typology module		*Output from sensitivity module*		*Output from sensitivity module*		*Output from pressure module*

Table 5.23: Impact Assessment of Shoreline Reinforcement (High Impact) in a water body typed as Transitional meso to macro tidal

	Transitional				
	Meso - macro tidal				
Ecogeomorphic Attributes	Relevance	Ecological Sensitivity	Morphological Sensitivity	Likelihood of Impact	IMPACT
Hydrodynamics					**0.06**
Open Water					**0.125**
Tidal Range	**1**	**0.5**	**0.5**	**0**	**0**
Currents	**1**	**0.5**	**0.5**	**0**	**0**
Waves	**1**	**0.5**	**0.5**	**0.5**	**0.125**
Freshwater Influence					**0**
Flushing/exchange	**1**	**0.5**	**0.5**	**0**	**0**
Salinity/mixing/stratification	**1**	**0.5**	**0.5**	**0**	**0**
Freshwater Flow	**1**	**0.5**	**0.5**	**0**	**0**
Intertidal Zone					**0.17**
Geometry					**0**
Planform	**1**	**1**	**1**	**0**	**0**
Profile	**1**	**0.5**	**0.5**	**0**	**0**
Morphological features & substrate					**0.25**
Nature and extent of coastal features	**1**	**1**	**0.5**	**0.5**	**0.25**
Natural sediment size range	**1**	**0.5**	**0.5**	**0.5**	**0.125**
Continuity and sediment supply					**0.25**
Longitudinal sediment transport processes	**1**	**0.5**	**0.5**	**0.5**	**0.125**
Lateral sediment transport processes	**1**	**0.5**	**1**	**0.5**	**0.25**
Subtidal Zone					**0.21**
Geometry					**0.125**
Planform	**1**	**1**	**1**	**0**	**0**
Profile	**1**	**0.5**	**0.5**	**0.5**	**0.125**
Morphological features & substrate					**0.25**
Nature and extent of coastal features	**1**	**1**	**0.5**	**0.5**	**0.25**
Natural sediment size range	**1**	**0.5**	**0.5**	**0.5**	**0.125**
Continuity and sediment supply					**0.25**
Longitudinal sediment transport processes	**1**	**0.5**	**1**	**0.5**	**0.25**
Lateral sediment transport processes	**1**	**0.5**	**0.5**	**0.5**	**0.125**

The impact score calculated for Shoreline Reinforcement (high impact) in each tidal zone of this water body type is then multiplied by the Zone of Impact to estimate the overall Impact Rating for the pressure.

Example: Intertidal zone of Clonakility Harbour subject to shoreline reinforcement (high impact)

Impact Rating	=	Relevance	X	Ecological Sensitivity	X	Morphological Sensitivity	X	Likelihood of Impact	X	Zone of Impact
		Output from typology module		Output from sensitivity module		Output from sensitivity module		Output from pressure module		Output from pressure module
0.17	=			0.17					X	1

The percentage capacity used within Clonakilty Harbour is then estimated by combining the impact ratings of all existing pressures for each tidal zone. Table 5.24 below shows how this was calculated using the equation below. As noted in Section 5.2.5 of this report; the 'assessment unit' is the total water body area for the hydrodynamics, shoreline length and intertidal area for the intertidal zone, and shoreline length and subtidal area for the subtidal zone.

$$\text{Capacity Used (\%)} = \sum n \left(\frac{\text{Impact rating} \times \text{Footprint of morphological alteration}}{\text{Length/area of assessment unit}} \right) \times 100$$

Table 5.24: Summary of how the % System Capacity was calculated for Clonakilty Harbour

	Pressure Footprints		Impact Ratings			Impact Rating x Pressure Footprint		
	Intertidal	Subtidal	Hydrodynamics	Intertidal Zone	Subtidal Zone	Hydrodynamics	Intertidal Zone	Subtidal Zone
Shoreline Reinforcement (High)	5.108	0.070	0.06	0.17	0.31	0.32	0.85	0.02
Land Claim (High)	0.030933	0.00109	0.50	1.33	1.33	0.02	0.04	0.00
Embankment	2.014	0	0.00	0.17	0.13	0.00	0.34	0.00
Flow and Sediment Manipulation Structures	0.002029	0	0.06	0.31	0.31	0.00	0.00	0.00
			Total Impact Rating per Tidal Zone			0.34	1.23	0.02
Shoreline Length (km)	10.478		Water Body Areas (km^2)			1.80	1.69	0.11
			% Capacity Used - Areal Pressures				2.48	1.29
			% Capacity Used - Linear Pressures				11.33	0.21
			Total % Capacity Used			**18.8**	**13.8**	**1.5**

5.4.2 Development and approval stages of TraC-MImAS for use as a morphological assessment tool in Ireland

The development of TraC-MImAS has been ongoing within SEPA since mid-2006. Prior to TraC-MImAS, the Marine Morphology study investigated the use of 'Metrics' which were being developed by the Environment Agency in association with SNIFFER. This project, titled 'Development of Hydromorphological Reference Conditions and Draft Classification Scheme for Transitional and Coastal Waters', aimed to develop hydromorphological reference conditions and a draft classification scheme for TraC waters, defining only high status and the boundary between high/good. As with TraC-MImAS, the threshold limits proposed by this study were largely based on expert judgement due to the "considerable limitations in current understanding and availability of data" (SNIFFER, 2007). Table 5.25 below summarises the nine metrics proposed by this project for the classification of TraC waters.

Table 5.25: Summary of Metrics and thresholds

Metric	Description	Assessment Threshold
1	Habitat loss	% habitat loss
2	Changes in sediment budget & composition	Length of frontage influenced by reinforcement or beach management/ total length of WB frontage.
3a	Changes in morphology: Bed disturbance	Relative bed disturbance in relation to WB sensitivity (take account of fishing gear type)
3b	Changes in sediment budget & composition	Qualitative assessment based on expert judgement of available evidence & locations/extent of dredging/ reclamation activities
4	Hydromorphological element: hydrological conditions /	Area influenced by structures/ area of WB
	Changes in forces: Waves	
5	Changes in forces: Tides	Presence/ absence of artificial barrages etc.
6	Changes in forces: River flow	Is river flow at downstream assessment point of the adjacent river WB at high status (10%less than QN95)?
7a	Changes in forces: Stratification/flushing	Sea lough
7b	Salinity	% of area or length influenced

As these metrics were developed for high/good boundary assessments only; greater emphasis was required for "ensuring that the biological classification scheme incorporated metrics that were sensitive to hydromorphological changes" (SNIFFER, 2007).

In July 2006, a UKTAG Special Transitional and Coastal Water Body meeting was held in Edinburgh to determine if, and how, environmental standards could be developed for TraC waters within the time scales required of the first river basin planning cycle. Both the River MImAS tool and the Metrics tabulated above were presented by SEPA and the EA respectively. It was concluded at this meeting that the framework currently being developed for the Metrics would require further development within a more structured framework to allow environmental standards to be developed and approved. UKTAG requested that SEPA and the EA compare the two assessment methods and determine if the MImAS framework could be successfully adopted for TraC waters. It was confirmed to UKTAG that the scientific principles underpinning MImAS were transferable to TraC waters; therefore work on the draft tool commenced.

As part of the development process, and to provide consistency throughout Ireland and the UK, SEPA requested that TraC-MImAS was trialled for a selection of water bodies. As of August 2007, both Scotland and Ireland had completed trials for 34 water bodies. The purpose of the trials was to test the appropriateness of the MCLs and the also the framework in which MImAS is applied to support regulation.

Trial workshops were held by RPS Consulting and Jacobs in Belfast and Dublin. Representatives from the EPA, Marine Institute, and Environment Heritage Service (EHS) provided guidance and feedback on the proposed TraC-MImAS tool and trial results. Following the trials in Irish water bodies, TraC-MImAS was approved by the Marine Morphology Steering Group as a risk assessment tool suitable for the further characterisation of TraC water bodies.

The results of the RoI trials, outlined in Appendix 6-1, were submitted to SEPA in September 2007 for incorporation with those of Scotland and Northern Ireland to assist with further development/refinement of the tool.

TraC-MImAS was updated on completion of both these trials and an external technical review undertaken by Anton Edwards of Metoc Environmental Consultants. In November

2007, the UK-Ireland Marine Task Team endorsed TraC-MImAS as a **regulatory *support* tool** and also agreed that in the absence of other assessment tools TraC-MImAS is **suitable as a *support* tool for classification** pending further development. The further development of the typology module of this tool was a key recommendation of this group. With regard to the further development of the MCLs; further field assessments including investigative monitoring are required to refine the association of these values with morphological and ecological status class, this is discussed further within Chapters 9 and 10.

Following endorsement by the both the Marine Morphology Steering Group and Marine Task Team, TraC-MImAS was applied to Irish TraC water bodies for the purpose of further characterising the risk associated with anthropogenic physical alterations.

6 FURTHER CHARACTERISATION METHODOLOGY & OUTCOMES

6.1 Introduction ... 1
6.2 Methodology – Further Characterisation ... 4
6.2.1 Assumptions ... 4
6.2.2 Water Body Typology ... 4
6.2.3 TraC-MImAS Application (Steps 1 – 3) ... 6
6.3 Results – Further Characterisation ... 11
6.3.1 Results of Step 1 ... 16
6.3.2 Results of Step 2 ... 16
6.3.3 Results of Step 3 ... 17
6.3.4 Water bodies further characterised as at risk of failing to achieve Good Ecological Status ... 31
6.3.5 Results Summary ... 31

6.1 Introduction

Following the further characterisation of pressures on the morphology of TraC water bodies (as described in Chapter 3), further characterisation of the risk to TraC waters resulting from these pressure types was then required.

With the approval from the Marine Morphology Steering Group, TraC-MImAS was selected as an appropriate tool to further characterise the risk of TraC water bodies failing to meet the WFD objectives by 2015. TraC-MImAS version M2f (final) was used for the assessment of Irish TraC water bodies.

Prior to the final application of this version of TraC-MImAS, earlier versions were trialled to facilitate the development of the tool. TraC-MImAS version M2d was trialled in five Irish water bodies:

- Cork Harbour
- Castlemaine Harbour
- Cromane
- Inner Bantry Bay
- Outer Dingle Bay

The results of these trials, outlined in Appendix 6-1, were submitted to SEPA in September 2007 for inclusion with those of Scotland and Northern Ireland to assist with further development/refinement of the tool.

Also, at the request of the Heavily Modified and Artificial Water Body PoMS team, TraC-MImAS versions M2(d) and (f) were applied to two provisionally HMWBs; the Cashen and Upper Feale Estuaries. The results of both assessments are outlined in Appendix 6-2.

TraC-MImAS expresses the risk of a water body failing WFD objectives by indicating the potential ecological status class that may be achieved based on the water body type and pressure extents identified. As noted in Section 5.2 of this report, TraC-MImAS is based on the assumption that an assessment of impacts on ecologically relevant features and processes can be used to protect morphology and ecology. A result of 'Good' for example, indicates that this water body is potentially at risk of failing to achieve high morphological status and in turn high ecological status. It is important to note that the results outlined within this chapter are wholly based on the detailed risk assessment undertaken for the purpose of further characterising TraC waters, and any reference to status class boundaries are wholly based on this risk assessment and have not been verified by field assessments or reference to biological classification. At the time of writing biological classification results were incomplete.

The formal classification of morphological status for TraC water bodies in Ireland is outside the scope of the Marine Morphology Study. However, in the absence of monitoring results and a formal classification system it is likely that the classification of TraC water bodies for the first RBMP will incorporate the outputs of this study, particularly the application of TraC-MImAS. This study has received a formal request from the EPA to apply TraC-MImAS to 23 water bodies that may be potentially classed as HES following the application of draft classification tools; a proportion of which were already identified for assessment as part of this study. The results of TraC-MImAS assessment of the remaining water bodies are detailed in Appendix 6-3.

Member States are only required to report on morphology for those water bodies designated as 'High' status. For these water bodies it is assumed the EC will require information on the normative definitions, for example the structure of the water body's intertidal zone indicates little or no human impacts. TraC-MImAS can only indicate the likely risk to these quality elements; monitoring results are required to quantify these risks.

The Marine Morphology Study relates to the ***morphology*** of TraC water bodies and does not give significant focus to ***hydrology***. Hydrology was assessed separately by the initial risk assessments and is given limited consideration within TraC-MImAS. It is considered that the EPA will lead the development of a hydrology classification tool within their Marine Group and that this tool will use the Q95 data which will potentially act as a 'bolt-on' to TraC-MImAS to help support classification of transitional water bodies. Q95 is the average river flow for any 1 day expected to be greater for 95 days in any 100 days, i.e. the flow that would be exceed 95% of the time, and generally expressed as m^3 per second. It is a flow which generally only occurs in summer when rainfall is reduced.

The UK-Ireland Marine Task Team recently (Nov 2007) endorsed TraC-MImAS as a regulatory ***support*** tool and also agreed that, in the absence of other assessment tools, TraC-MImAS is suitable as a ***support*** tool for classification. In line with this endorsement, the further development of the typology module of TraC-MImAS was a key recommendation of this group. As noted in Section 5.2.2 of this report, the impact assessment within TraC-MImAS is largely based on the water body type, therefore refinement of the typology module would prove very beneficial to the future use of this tool for both regulation and classification.

As described in Chapter 1 of this report, the initial risk assessments assigned risk categories (risk of not achieving Good Status) to each TraC water body based on the proportion of the water body altered by human activities. However, as the initial risk assessments were based on screening or semi-quantitative assessments, results adopted the four-category risk scheme:

1a – at risk

1b – probably at risk

2a – probably not at risk

2b – not at risk

Where information was either lacking or of low confidence, the water body was assigned to either a 'probably at risk' or 'probably not a risk' category.

6.2 Methodology – Further Characterisation

There are 309 TraC waters in Ireland, and at the time of writing 13 were provisionally designated as Heavily Modified Water Bodies (pHMWB). TraC-MImAS was not applied to pHMWBs as designation indicates the failure of these water bodies to achieve GES due to the water body's 'specified use'. On formal designation of HMWBs, specific PoMs will be developed for each with the aim of achieving GEP.

6.2.1 Assumptions

Classification systems for morphology are incomplete and therefore formal results are unavailable at present. Consequently the impact of morphology on ecology has yet to be formally defined for Irish TraC waters. In the absence of these systems the following has been assumed to allow the PoMs to be informed by the Marine Morphology Study:

i. The Initial Risk Assessment risk category '1a' (at risk) indicates that the morphological status of a water body is less than Good.
ii. The Initial Risk Assessment risk category '2b' (not at risk) indicates that the morphological status of a water body is Good or High.
iii. PoMs for water bodies characterised as 'at risk' from 'other factors' such as pollution or marine direct impacts (nutrients and hazardous substances) in addition to morphology factors, will be focused on the 'other factors' for the first RBMP in order to achieve GES; morphology will then only be required for the achievement of HES. Therefore, TraC-MImAS was not applied to water bodies characterised in the initial risk assessments as 'at risk' (1a) from other factors. The hierarchy relating to the achievement of GES and HES is illustrated in Figure 1.1 earlier in this report.

6.2.2 Water Body Typology

As noted in section 5.2.2 previously, further characterisation of TraC water body types, defined by System B for the WFD, to be bodies of "similar physical character that respond to pressures in predictable ways" is required to facilitate their assessment with TraC-MImAS. It is intended that these TraC-MImAS water body types reflect the presence and character of the attributes identified in the Attribute Module of TraC-MImAS.

Table 6.1 below shows how the MImAS water body types can be assigned to the WFD water body codes (those prominent in Ireland are shown in bold text). The conversion of water body types between the two systems is unique except for water bodies CW1 to CW9 where there is a choice of two possibilities.

Table 6.1: WFD and TraC-MImAS water body types

<table>
<tr><th>WFD Type</th><th colspan="2">TraC-MImAS Water Body Types</th></tr>
<tr><td>TW1
TW2
TW3
TW4</td><td>Transtional Meso to Macrotidal</td><td></td></tr>
<tr><td>CW1
CW2
CW3
CW4
CW5
CW6</td><td>Moderately to Exposed Coastal - Sedimentary</td><td rowspan="2">Coastal Bedrock</td></tr>
<tr><td>CW7
CW8
CW9</td><td>Sheltered Coastal – Sedimentary</td></tr>
<tr><td>TW6
CW10</td><td>TraC Lagoons</td><td rowspan="2"></td></tr>
<tr><td>TW5
CW11
CW12</td><td>TraC Sea Lochs</td></tr>
</table>

The following resources were used to define TraC-MImAS water body types for all 309 water bodies:

- WFD and TraC-MImAS water body conversion table (Table 6.1)
- WFD water body typology elements
- Orthophotos
- Oblique images
- Professional judgement (Marine Morphology Steering Group)

Advice from the Steering Group was sought for the water bodies trialled using the earlier TraC-MImAS (vers M2d) and various coastal water bodies for which two different TraC-MImAS water body types could be identified. On assigning TraC-MImAS water body types a conservative approach was taken. For example, if a water body, such as the North Atlantic Seaboard, or Clonakilty Bay could be classed as 'Coastal Bedrock' in some areas and 'Moderately exposed to exposed coast, sedimentary' in a large proportion of other areas, the more sensitive code, i.e. the latter, was assigned.

6.2.3 TraC-MImAS Application (Steps 1 – 3)

Using the method outlined below, 122 TraC water bodies were identified for assessment (and further characterisation) using TraC-MImAS. Tables 6.2 and 6.3 below tabulate these water bodies as identified by each of the three steps below, and summarise the risk categories assigned to each by the initial risk assessments.

Step 1

Aim: To further characterise those water bodies identified as 'probably at risk' and 'probably not at risk' from morphology by providing an indication of risk to status class.

MImAS was applied to all water bodies identified as 'probably at risk' (1b) and 'probably not at risk' (2a) from morphology, with the exception of those that have been characterised as 'at risk' (1a) from other factors such as pollution or marine direct impacts. This exclusion of 'at risk' (1a) water bodies is based on the assumption made in section 6.2.1(iii).

On completion of Step 1; 77 water bodies (53 transitional, and 24 coastal) were identified for assessment.

Step 2

Aim: Further characterise those water bodies that could potentially achieve GES or HES if morphology was restored or mitigated.

MImAS was applied to those remaining 'at risk' water bodies where morphology is the only factor contributing to an 'at risk' (1a) characterisation.

On completion of Step 2, 27 water bodies (22 transitional, and 5 coastal) were identified for assessment.

Step 3

Aim: To identify those water bodies unlikely to be at risk of failing HES based on the assumption that the morphological attributes assessed support ecological function.

On prioritising water bodies for assessment using TraC-MImAS, it was assumed that those water bodies initially characterised as 'not at risk' (2b) were likely to be subject to little or no morphological pressures, and therefore excluded from assessment. However, before it can be assumed these water bodies are unlikely to be at risk of failing to achieve HES, further characterisation was required to confirm if this assumption was correct.

The estimated pressure footprints for all 309 TraC water bodies were reviewed within ArcGIS to determine the presence and extents of any pressures identified for those water bodies initially characterised as 'not at risk' (2b). Water bodies for which no pressures footprints were identified should retain the characterisation of 'not at risk', and may be assumed as likely to achieve high morphological status, and therefore have the potential to achieve HES. A similar approach has been applied by SEPA on classifying Scottish TraC waters; assigning any water bodies with no or minimal pressure footprints to High Status.

Whilst undertaking this assessment it was identified that 84 water bodies initially characterised as 'not at risk' (2b) contained pressure footprints. From these 84 (2b) water bodies, 54 were identified as potentially subject to extensive pressures, i.e. the footprint of a particular pressure extended over 5% of the water body's area or shoreline length. The further assessment of potential risk of these water bodies failing to meet WFD objectives was then required.

Of these 54 water bodies, the pressure 'Other Disturbances to Seabed' was identified as the primary footprint extending over 5% of the water body area in 39 water bodies. As this pressure type is largely associated with the estimated locations of shellfish dredging (detailed assessment of which is outside the scope of this study) these water bodies were not reviewed further. The remaining 18 (2b) water bodies potentially subject to extensive pressures were identified for assessment with TraC-MImAS.

An exception to the rule relating to 'Other Disturbances to Seabed' footprints was made for the water bodies Outer Kenmare River, Inner Kenmare River, and Outer Dingle Bay, all of which are associated with shellfish dredging. These water bodies were assessed during the initial trials for TraC-MImAS, and it was therefore considered appropriate to further characterise these water bodies using the most recent version of the assessment tool.

On completion of Step 3, 18 water bodies (4 transitional, and 14 coastal) were identified for assessment.

The total number of water bodies identified by Steps 1 – 3 for further characterisation was ***122***.

Table 6.2: Coastal Water Bodies identified for assessment with TraC-MImAS (42 No.)

Water Body Code	Water Body Name	Water Body Type	TraC-MImAS Water Body Type	Marine Direct Impacts	Pollution	Point Source Discharges	Morphology Risk	Overall Risk	MImAS Application Step
GBNIIE6NB030	Carlingford Lough (NB_030_0000)	CW8	Sheltered coast, sedimentary	1b	1b	1b	**1b**	1b	**1**
IE_NB_040_0000	Outer Dundalk Bay	CW5	Moderately exposed to exposed coast, sedimentary		1b		**1b**	1b	**1**
IE_SW_240_0000	Dingle Harbour	CW5	Moderately exposed to exposed coast, sedimentary				**1b**	1b	**1**
IE_WE_100_0000	Outer Galway Bay	CW2	Moderately exposed to exposed coast, sedimentary		2a	2a	**1b**	1b	**1**
GBNIIE6NW250	Lough Foyle (NW_250_0000)	CW8	Sheltered coast, sedimentary	1b	1b	1b	**1b**	1b	**1**
IE_EA_140_0000	Southwestern Irish Sea - Brittas Bay (HA 10)	CW6	Moderately exposed to exposed coast, sedimentary		2b	2b	**1b**	1b	**1**
IE_SE_010_0000	Southwestern Irish Sea (Has 11;12)	CW5	Moderately exposed to exposed coast, sedimentary				**1b**	1b	**1**
IE_SE_040_0000	Wexford Harbour	CW8	Sheltered coast, sedimentary	1b	1b		**1b**	1b	**1**
IE_SE_110_0000	Tramore Bay	CW5	Moderately exposed to exposed coast, sedimentary				**1b**	1b	**1**
IE_SE_140_0000	Dungarvan Harbour	CW5	Moderately exposed to exposed coast, sedimentary	1b	1b		**1b**	1b	**1**
IE_SW_040_0000	Ballycotton Bay	CW5	Moderately exposed to exposed coast, sedimentary				**1b**	1b	**1**
IE_SE_120_0000	Tramore Back Strand	CW8	Sheltered coast, sedimentary				**1b**	1b	**1**
IE_EA_070_0000	Irish Sea Dublin (HA 09)	CW5	Moderately exposed to exposed coast, sedimentary		2b	2b	**2a**	2a	**1**
IE_WE_170_0000	Inner Galway Bay North	CW5	Moderately exposed to exposed coast, sedimentary		2a	2a	**2a**	2a	**1**
IE_EA_020_0000	Northwestern Irish Sea (HA 08)	CW5	Moderately exposed to exposed coast, sedimentary		2b	2b	**2a**	2a	**1**
IE_NW_170_0000	Ballyness Bay	CW5	Moderately exposed to exposed coast, sedimentary		2a		**2a**	2a	**1**
IE_NW_190_0000	Sheephaven Bay	CW5	Moderately exposed to exposed coast, sedimentary		2a		**2a**	2a	**1**
IE_SE_050_0000	Eastern Celtic Sea (HAs 13;17)	CW2	Moderately exposed to exposed coast, sedimentary				**2a**	2a	**1**
IE_SE_090_0000	Bannow Bay	CW8	Sheltered coast, sedimentary				**2a**	2a	**1**
IE_SE_100_0000	Waterford Harbour	CW2	Moderately exposed to exposed coast, sedimentary				**2a**	2a	**1**
IE_SH_060_0000	Mouth of the Shannon (HAs 23;27)	CW2	Moderately exposed to exposed coast, sedimentary		2a		**2a**	2a	**1**
IE_SH_100_0000	Liscannor Bay	CW2	Moderately exposed to exposed coast, sedimentary		2b		**2a**	2a	**1**
IE_SW_110_0000	Rosscarbery Bay	CW5	Coastal bedrock				**2a**	2a	**1**
IE_WE_360_0000	Blacksod Bay	CW5	Moderately exposed to exposed coast, sedimentary		2a	2a	**2a**	2a	**1**
IE_WE_470_0000	Sligo Harbour	CW8	Sheltered coast, sedimentary		2a	2a	**1a**	1a	**2**
IE_EA_010_0000	Boyne Estuary Plume Zone	CW5	Moderately exposed to exposed coast, sedimentary	1b	1b	2b	**1a**	1a	**2**
IE_EA_100_0000	Southwestern Irish Sea - Killiney Bay (HA10)	CW5	Moderately exposed to exposed coast, sedimentary		2b	2b	**1a**	1a	**2**
IE_WE_190_0000	Casla Bay	CW5	Coastal bedrock		2b	2b	**1a**	1a	**2**
IE_SH_050_0000	Inner Tralee Bay	CW8	Sheltered coast, sedimentary		2b		**1a**	1a	**2**
IE_SH_040_0000	Outer Tralee Bay	CW5	Moderately exposed to exposed coast, sedimentary		2b		**2b**	2b	**3**
IE_SW_100_0300	White's Marsh	CW10	TraC lagoons			2b	**2b**	2a	**3**
IE_SW_170_0000	Outer Bantry Bay	CW2	Coastal bedrock	2b	2b		**2b**	2b	**3**
IE_SW_190_0000	Outer Kenmare River	CW2	Coastal bedrock	1b	1b		**2b**	1b	**3**
IE_WE_420_0000	Killala Bay	CW5	Moderately exposed to exposed coast, sedimentary		2a	2a	**2b**	2a	**3**
IE_NW_070_0000	Donegal Bay Northern	CW2	Coastal bedrock		2b		**2b**	2b	**3**
IE_NW_220_0000	Lough Swilly	CW5	Moderately exposed to exposed coast, sedimentary		2b		**2b**	2b	**3**
IE_SH_010_0000	Southwestern Atlantic Seaboard (HA 23)	CW2	Coastal bedrock		2b		**2b**	2b	**3**
IE_SW_050_0000	Outer Cork Harbour	CW5	Moderately exposed to exposed coast, sedimentary				**2b**	2b	**3**
IE_SW_230_0000	Outer Dingle Bay	CW2	Coastal bedrock				**2b**	2b	**3**
IE_WE_430_0000	Donegal Bay Southern	CW2	Moderately exposed to exposed coast, sedimentary		2a	2a	**2b**	2a	**3**
IE_WE_450_0000	Sligo Bay	CW5	Moderately exposed to exposed coast, sedimentary		2a	2a	**2b**	2a	**3**
IE_SW_180_0000	Berehaven	CW5	Moderately exposed to exposed coast, sedimentary				**2b**	2b	**3**

Table 6.3: Transitional Water Bodies identified for assessment with TraC-MImAS (80 No.)

Water Body Code	Water Body Name	Water Body Type	TraC-MImAS Water Body Type	Abstraction	Marine Direct Impacts	Pollution	Point Source Discharges	Morphology Risk	Overall Risk	MImAS Application Step
IE_SE_020_0100	Owenavorragh Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	1b	1b	1
IE_SE_080_0100	Bridgetown Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1b	1b	1
IE_SW_230_0200	Castlemaine Harbour	TW2	Transitional meso to macrotidal	2b		1b	1b	1b	1b	1
IE_SH_060_1200	Clonderalaw Bay	TW2	Transitional meso to macrotidal	2b		2b	2b	1b	1b	1
IE_SW_190_0500	Drongawn Lough, Sneem	TW6	TraC lagoons	2b		2b	2b	1b	1b	1
GBNIIE5NW250010	Foyle and Faughan Estuaries	TW2	Transitional meso to macrotidal	2b		1b	1b	1b	1b	1
IE_NW_220_0300	Inch Lough	TW6	TraC lagoons	2b		2a	2a	1b	1b	1
IE_SW_060_1200	Owenboy Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	1b	1b	1
IE_SW_030_0100	Womanagh Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1b	1b	1
IE_NB_040_0300	Ballymascanlan Estuary	TW2	Transitional meso to macrotidal	2a		2b	2b	1b	1b	1
IE_WE_410_0100	Bunatrahir Bay	TW2	Transitional meso to macrotidal	2b		2b	2b	1b	1b	1
IE_NW_030_0100	Erne Estuary	TW2	Transitional meso to macrotidal	1b		1b	1b	1b	1b	1
IE_EA_080_0100	Mayne Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	1b	1b	1
IE_SE_040_0100	North Slob Channels	TW6	TraC lagoons	2b		2b	2b	1b	1b	1
IE_WE_400_0200	Sruwaddacon Bay	TW2	Transitional meso to macrotidal	2b		2a	2a	1b	1b	1
IE_SE_070_0100	Tacumshin Lake	TW6	TraC lagoons	2b		2b	2b	1b	1b	1
IE_NW_090_0100	Teelin Bay	TW2	Transitional meso to macrotidal	2b		2b	2b	1b	1b	1
IE_WE_390_0100	Tullaghan Bay	TW2	Transitional meso to macrotidal	2b		2a	2a	1b	1b	1
IE_EA_050_0100	Rogerstown Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	1b	1b	1
IE_SW_110_0200	Rosscarbery Harbour	TW6	TraC lagoons	2b		1b	1b	1b	1b	1
IE_NW_220_0100	Swilly Estuary	TW2	Transitional meso to macrotidal	2b		2a	2a	1b	1b	1
IE_SE_100_0100	Barrow Suir Nore Estuary	TW2	Transitional meso to macrotidal	2b	1b	1b	2b	2a	1b	1
IE_WE_160_0800	Dunbulcaun Bay	TW2	Transitional meso to macrotidal	2b		2a	2a	2a	2a	1
IE_SW_190_0200	Kilmakilloge Harbour	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_WE_160_0100	Kinvarra Bay	TW2	Transitional meso to macrotidal	2b		1b	1b	2a	1b	1
IE_WE_350_0100	Westport Bay	TW2	Transitional meso to macrotidal	2b		1b	1b	2a	1b	1
IE_SW_170_0500	Adrigole Harbour	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_SH_110_0100	Aille Clare Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_SW_090_0200	Argideen Estuary	TW2	Transitional meso to macrotidal	2a		1b	1b	2a	1b	1
IE_SH_050_0200	Blennerville Lake East	TW6	TraC lagoons	2b		2b	2b	2a	2a	1
IE_SH_050_0300	Blennerville Lake West	TW6	TraC lagoons	2b		2b	2b	2a	2a	1
IE_NW_200_0200	Carrick Beg Lough (South)	TW6	TraC lagoons	2a		2a	2a	2a	2a	1
IE_SE_140_0100	Colligan Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	2a	1b	1
IE_SE_090_0100	Corock Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_NW_220_0400	Crana Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_SH_080_0100	Doonbeg Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_NW_040_0100	Durnesh Lough	TW6	TraC lagoons	2b		2a	2a	2a	2b	1
IE_WE_440_0100	Easky Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_WE_350_0300	Furnace Lough	TW6	TraC lagoons	2b		1b	1b	2a	1b	1
IE_SW_170_0400	Glengarriff Harbour	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_SH_100_0100	Inagh Estuary	TW2	Transitional meso to macrotidal	2a		1b	1b	2a	1b	1
IE_EA_120_0100	Kilcoole Marsh	TW6	TraC lagoons	2b		1b	1b	2a	1b	1
IE_SE_060_0100	Lady's Island Lake	TW6	TraC lagoons	2b		1b	1b	2a	1b	1
IE_NW_160_0100	Loch Chionn Caslach (Kincas L.)	TW6	TraC lagoons	2a		2a	2a	2a	2a	1
IE_NW_180_0100	Loch O Dheas, Tory Island	TW6	TraC lagoons	2a		2a	2a	2a	2a	1
IE_SH_040_0100	Lough Gill	TW6	TraC lagoons	2a		2b	2b	2a	2a	1
IE_NW_140_0100	Maghery Lough	TW6	TraC lagoons	2a		2a	2a	2a	2a	1
IE_NW_160_0300	Moorlagh	TW6	TraC lagoons	2b		2a	2a	2a	2b	1
IE_EA_030_0100	Nanny Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	2a	1b	1
GBNIIE5NB030010	Newry Estuary (NB_030_0100)	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_SW_070_0100	Oysterhaven	TW2	Transitional meso to macrotidal	2b		2b	2b	2a	2a	1
IE_SH_060_0400	Poulaweala Lough / Quayfield Lo	TW6	TraC lagoons	2b		2a	2a	2a	2a	1
IE_SW_100_0100	Clonakilty Harbour	TW2	Transitional meso to macrotidal	2b		1b	1b	2a	1b	1
IE_EA_010_0100	Boyne Estuary	TW2	Transitional meso to macrotidal	2a	1b	1b	1b	1a	1a	2
IE_EA_130_0100	Broad Lough	TW2	Transitional meso to macrotidal	2b		1b	1b	1a	1a	2
IE_WE_170_0700	Corrib Estuary	TW2	Transitional meso to macrotidal	2b		2a	2a	1a	1a	2
IE_EA_110_0100	Dargle Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1a	1a	2
IE_SH_060_1100	Fergus Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	1a	1a	2
IE_WE_470_0100	Garavoge Estuary	TW2	Transitional meso to macrotidal	2b	1b	1b	1b	1a	1a	2
IE_NB_040_0100	Inner Dundalk Bay	TW2	Transitional meso to macrotidal	2b		1b	1b	1a	1a	2
IE_WE_160_0600	Lough Sallagh (Doorus Loughs)	TW6	TraC lagoons	2b		2b	2b	1a	1a	2
IE_SH_060_0800	Upper Shannon Estuary	TW2	Transitional meso to macrotidal	2b		1b	1b	1a	1a	2
IE_WE_170_0300	Ardfry Oyster Pool	TW6	TraC lagoons	2b		2a	2a	1a	1a	2
IE_WE_190_0100	Casla Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1a	1a	2
IE_WE_310_0100	Erriff Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1a	1a	2
IE_SW_170_0100	Inner Bantry Bay	TW2	Transitional meso to macrotidal	2b		1b	1b	1a	1a	2
IE_WE_170_0600	Renmore Lough, Galway City	TW6	TraC lagoons	2b		2b	2b	1a	1a	2
IE_SH_060_1000	Shannon Airport Lagoon	TW6	TraC lagoons	2b		1b	1b	1a	1a	2
IE_NB_030_0250	Shilties Lough	TW6	TraC lagoons	2b		2b	2b	1a	1a	2
IE_SE_040_0400	South Slob Channel	TW6	TraC lagoons	2b		2b	2b	1a	1a	2
IE_SE_080_0200	Ballyteige Channels	TW6	TraC lagoons	2b		2b	2b	1a	1a	2
IE_NW_220_0200	Blanket Nook Lough	TW6	TraC lagoons	2b		2a	2a	1a	1a	2
IE_NW_010_0100	Duff Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1a	1a	2
IE_NB_040_0400	Fane Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	1a	1a	2
IE_NB_040_0500	Glyde Estuary	TW2	Transitional meso to macrotidal	2a		2b	2b	1a	1a	2
IE_SE_140_0200	Brickey Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2b	2b	3
IE_SW_190_0300	Inner Kenmare River	TW2	Transitional meso to macrotidal	2b		2b	2b	2b	2b	3
IE_SW_230_0100	Cromane	TW2	Transitional meso to macrotidal	2b	1b	1b	1b	2b	1b	3
IE_NW_160_0500	Meenaclady	TW2	Transitional meso to macrotidal	2a		2b	2b	2b	2a	3
IE_WE_180_0100	Spiddal Estuary	TW2	Transitional meso to macrotidal	2b		2b	2b	2b	2b	3

Table 6.4 below summarises the distribution of TraC water bodies across the Initial Risk Assessment morphology risk categories, and those identified for assessment.

Table 6.4: Distribution of TraC water bodies between Initial Risk Assessment morphology risk categories & summary of those further characterised using TraC-MImAS

	No. Water Bodies	1a 'at risk'	1b 'probably at risk'	2a 'probably not at risk'	2b 'not at risk'
Total Water Bodies	309	49	42	58	160
TraC-MImAS (Steps 1 - 3)	122	27	33	44	18
Water Bodies not Assessed	187	22	9	14	142
Water Bodies with Identified Pressure Footprints	200	42	36	38	84
Water Bodies with no Identified Pressure Footprints	109	7	6	20	76
Water Bodies 'not at risk' (2b) with Identified Pressure Footprints >5%	18				18

6.3 Results – Further Characterisation

Table 6.5 and 6.6 below summarise the results for each of the water bodies assessed with TraC-MImAS (122 No.). The estimated percentage of system capacity currently used in each water body is expressed using the MCL range which each water body falls within. The overall risk for a water body was determined by the highest percentage capacity estimated for the three water body zones; hydrodynamic, intertidal, and subtidal. The MCLs discussed in Section 5.2.5 and Table 5.9 previously, are displayed next to the percentage capacity results to indicate which status class the water bodies are not likely to be at risk of failing, e.g. where pressures for all three zones of a water body are estimated to have used 7% of the water body's system capacity, this water body is considered unlikely to be at risk of failing GES as the MCLs for Good range from 5 to 14.9%. The use of these 'status' terms in further characterisation indicates **risk** to status class only, and does not represent classification results.

Water Body Summary Sheets have been generated for all water bodies estimated to be a risk of failing GES, and are included in Appendix 6-4.

Water body results highlighted in ***red italics*** in Tables 6.5 and 6.6 indicate where specific reservations about the TraC-MImAS results were identified. These water bodies were reviewed further and are discussed in section 6.3.3 below. Section 6.3.3 firstly outlines those water bodies categorised as 'not at risk' by the initial risk assessments, but estimated as having the potential to achieve HES following assessment with TraC-MImAS. Secondly, this section addresses those water bodies categorised as 'at risk' or 'probably at risk' due to intensive land use but for which no pressure footprints were identified during further characterisation by this study.

Appendix 6-3 outlines the overall results tables for the further characterisation of TraC water bodies. For those water bodies assessed with TraC-MImAS, this table details the percentage system capacities calculated for each water body zone. The initial risk assessment categories originally assigned to each water body are included for reference, and any comments specific to a water body are detailed where necessary. Included in this table are the results for additional water bodies assessed following a request from the EPA. As with Tables 6.5 and 6.6, any water bodies for which the results have been queried are highlighted in ***red italics***. To provide an indication of the level of confidence in results, Appendix 6-3 identifies those water bodies for which orthophotos were unavailable and therefore did not undergo detailed review for pressure extents (footprints).

Within Appendix 6-3, the overall risk associated with those water bodies assessed using TraC-MImAS is expressed as potential status class as with Tables 6.5 and 6.6 below. For those water bodies not assessed with TraC-MImAS, overall risk categories have been assumed based in the initial risk assessment results, pressure footprints, and discussions with the Marine Morphology Steering Group. The overall risk assigned to these water bodies is expressed as potential ***morphological*** status class:

'***Less than Good***' – this overall risk category is assigned to water bodies which are considered unlikely to achieve GES due to the status of morphology:

- pHMWBs
- Water bodies characterised as 'at risk' (1a) from other factors such as pollution or marine direct impacts, but also as 'at risk' (1a) or 'probably at risk' (1b) from morphology.

‘***At least Good***’ – this overall risk category is assigned to water bodies which are considered unlikely to achieve HES. In the absence of monitoring / classification results, ‘at least good’ is the highest potential status class that can be estimated for the morphology of the following water bodies:

- Water bodies characterised as ‘probably not at risk’ (2a) from morphology, but ‘at risk’ (1a) from other factors such as pollution or marine direct impacts.
- Water bodies characterised as ‘not at risk’ (2b) from morphology and not assessed using TraC-MImAS

Table 6.5: Summary TraC-MImAS results for coastal water bodies (sorted by MImAS Application Step (see Section 6.2.3))

Water Body Code	Water Body Name	Initial Risk Assessment - Morphology Risk	Initial Risk Assessment - Overall Risk	MImAS Application Step	% Capacity Used	Overall Risk expressed as Status Class
IE_SE_120_0000	Tramore Back Strand	1b	1b	1	15 - 29.9	Moderate
GBNIIE6NB030	Carlingford Lough (NB_030_0000)	1b	1b	1	5 - 14.9	Good
IE_EA_070_0000	Irish Sea Dublin (HA 09)	2a	2a	1		Good
IE_NB_040_0000	Outer Dundalk Bay	1b	1b	1		Good
IE_SW_240_0000	Dingle Harbour	1b	1b	1		Good
IE_WE_100_0000	Outer Galway Bay	1b	1b	1		Good
IE_WE_170_0000	Inner Galway Bay North	2a	2a	1		Good
GBNIIE6NW250	Lough Foyle (NW_250_0000)	1b	1b	1	0 - 4.9	High
IE_EA_020_0000	Northwestern Irish Sea (HA 08)	2a	2a	1		High
IE_EA_140_0000	Southwestern Irish Sea - Brittas Bay (HA 10)	1b	1b	1		High
IE_NW_170_0000	Ballyness Bay	2a	2a	1		High
IE_NW_190_0000	Sheephaven Bay	2a	2a	1		High
IE_SE_010_0000	Southwestern Irish Sea (HAs 11;12)	1b	1b	1		High
IE_SE_040_0000	Wexford Harbour	1b	1b	1		High
IE_SE_050_0000	Eastern Celtic Sea (HAs 13;17)	2a	2a	1		High
IE_SE_090_0000	Bannow Bay	2a	2a	1		High
IE_SE_100_0000	Waterford Harbour	2a	2a	1		High
IE_SE_110_0000	Tramore Bay	1b	1b	1		High
IE_SE_140_0000	Dungarvan Harbour	1b	1b	1		High
IE_SH_060_0000	Mouth of the Shannon (HAs 23;27)	2a	2a	1		High
IE_SH_100_0000	Liscannor Bay	2a	2a	1		High
IE_SW_040_0000	Ballycotton Bay	1b	1b	1		High
IE_SW_110_0000	Rosscarbery Bay	2a	2a	1		High
IE_WE_360_0000	Blacksod Bay	2a	2a	1		High
IE_SH_050_0000	Inner Tralee Bay	1a	1a	2	15 - 29.9	Moderate
IE_WE_470_0000	Sligo Harbour	1a	1a	2	5 - 14.9	Good
IE_EA_010_0000	Boyne Estuary Plume Zone	1a	1a	2	0 - 4.9	High
IE_EA_100_0000	Southwestern Irish Sea - Killiney Bay (HA10)	1a	1a	2		High
IE_WE_190_0000	Casla Bay	1a	1a	2		High
IE_SW_180_0000	Berehaven	2b	2b	3	30 - 44.9	Poor
IE_SH_040_0000	Outer Tralee Bay	2b	2b	3	5 - 14.9	Good
IE_SW_100_0300	White's Marsh	2b	2a	3		Good
IE_SW_170_0000	Outer Bantry Bay	2b	2b	3		Good
IE_SW_190_0000	Outer Kenmare River	2b	1b	3		Good
IE_WE_420_0000	Killala Bay	2b	2a	3	0 - 4.9	High
IE_NW_070_0000	Donegal Bay Northern	2b	2b	3		High
IE_NW_220_0000	Lough Swilly	2b	2b	3		High
IE_SH_010_0000	Southwestern Atlantic Seaboard (HA 23)	2b	2b	3		High
IE_SW_050_0000	Outer Cork Harbour	2b	2b	3		High
IE_SW_230_0000	Outer Dingle Bay	2b	2b	3		High
IE_WE_430_0000	Donegal Bay Southern	2b	2a	3		High
IE_WE_450_0000	Sligo Bay	2b	2a	3		High

% Capacity Used	HIGH	GOOD	MOD	POOR	BAD
	0 - 4.9	5 - 14.9	15 - 29.9	30 - 44.9	50 +

Table 6.6: Summary TraC-MImAS results for transitional water bodies (sorted by MImAS Application Step (see Section 6.2.3))

Water Body Code	Water Body Name	Initial Risk Assessment Morphology Risk	Initial Risk Assessment Overall Risk	MImAS Application Step	% Capacity Used	Overall Risk expressed as Status Class
IE_SE_020_0100	Owenavorragh Estuary	1b	1b	1	50 +	Bad
IE_EA_050_0100	Rogerstown Estuary	1b	1b	1		Moderate
IE_NW_220_0100	Swilly Estuary	1b	1b	1	15 - 29.9	Moderate
IE_SW_100_0100	Clonakilty Harbour	2a	1b	1		Moderate
IE_SW_110_0200	Rosscarbery Harbour	1b	1b	1		Moderate
GBNIIE5NW250010	Foyle and Faughan Estuaries	1b	1b	1		Good
IE_NW_220_0300	Inch Lough	1b	1b	1		Good
IE_SE_080_0100	Bridgetown Estuary	1b	1b	1		Good
IE_SE_100_0100	Barrow Suir Nore Estuary	2a	1b	1		Good
IE_SH_060_1200	Clonderalaw Bay	1b	1b	1		Good
IE_SW_030_0100	Womanagh Estuary	1b	1b	1		Good
IE_SW_060_1200	Owenboy Estuary	1b	1b	1	5 - 14.9	Good
IE_SW_190_0200	Kilmakilloge Harbour	2a	2a	1		Good
IE_SW_190_0500	Drongawn Lough, Sneem	1b	1b	1		Good
IE_SW_230_0200	Castlemaine Harbour	1b	1b	1		Good
IE_WE_160_0100	Kinvarra Bay	2a	1b	1		Good
IE_WE_160_0800	Dunbulcaun Bay	2a	2a	1		Good
IE_WE_350_0100	Westport Bay	2a	1b	1		Good
GBNIIE5NB030010	Newry Estuary (NB_030_0100)	2a	2a	1		High
IE_EA_030_0100	Nanny Estuary	2a	1b	1		High
IE_EA_080_0100	Mayne Estuary	1b	1b	1		High
IE_EA_120_0100	Kilcoole Marsh	2a	1b	1		High
IE_NB_040_0300	*Ballymascanlan Estuary*	*1b*	*1b*	*1*		*High*
IE_NW_030_0100	Erne Estuary	1b	1b	1		High
IE_NW_040_0100	Durnesh Lough	2a	2b	1		High
IE_NW_090_0100	Teelin Bay	1b	1b	1		High
IE_NW_140_0100	Maghery Lough	2a	2a	1		High
IE_NW_160_0100	Loch Chionn Caslach	2a	2a	1		High
IE_NW_160_0300	Moorlagh	2a	2b	1		High
IE_NW_180_0100	Loch O Dheas, Tory Island	2a	2a	1		High
IE_NW_200_0200	Carrick Beg Lough (South)	2a	2a	1		High
IE_NW_220_0400	Crana Estuary	2a	2a	1		High
IE_SE_040_0100	*North Slob Channels*	*1b*	*1b*	*1*		*High*
IE_SE_060_0100	Lady's Island Lake	2a	1b	1		High
IE_SE_070_0100	*Tacumshin Lake*	*1b*	*1b*	*1*		*High*
IE_SE_090_0100	Corock Estuary	2a	2a	1	0 - 4.9	High
IE_SE_140_0100	Colligan Estuary	2a	1b	1		High
IE_SH_040_0100	Lough Gill	2a	2a	1		High
IE_SH_050_0200	Blennerville Lake East	2a	2a	1		High
IE_SH_050_0300	Blennerville Lake West	2a	2a	1		High
IE_SH_060_0400	Poulaweala Lough / Quayfield	2a	2a	1		High
IE_SH_080_0100	Doonbeg Estuary	2a	2a	1		High
IE_SH_100_0100	Inagh Estuary	2a	1b	1		High
IE_SH_110_0100	Aille Clare Estuary	2a	2a	1		High
IE_SW_070_0100	Oysterhaven	2a	2a	1		High
IE_SW_090_0200	Argideen Estuary	2a	1b	1		High
IE_SW_170_0400	Glengarriff Harbour	2a	2a	1		High
IE_SW_170_0500	Adrigole Harbour	2a	2a	1		High
IE_WE_350_0300	Furnace Lough	2a	1b	1		High
IE_WE_390_0100	*Tullaghan Bay*	*1b*	*1b*	*1*		*High*
IE_WE_400_0200	Sruwaddacon Bay	1b	1b	1		High
IE_WE_410_0100	Bunatrahir Bay	1b	1b	1		High
IE_WE_440_0100	Easky Estuary	2a	2a	1		High
IE_EA_010_0100	Boyne Estuary	1a	1a	2	50 +	Bad
IE_NB_040_0400	Fane Estuary	1a	1a	2		Moderate
IE_NB_040_0500	Glyde Estuary	1a	1a	2		Moderate
IE_NW_010_0100	Duff Estuary	1a	1a	2	15 - 29.9	Moderate
IE_NW_220_0200	Blanket Nook Lough	1a	1a	2		Moderate
IE_SE_080_0200	Ballyteige Channels	1a	1a	2		Moderate
IE_EA_110_0100	Dargle Estuary	1a	1a	2		Good
IE_EA_130_0100	Broad Lough	1a	1a	2		Good
IE_NB_040_0100	Inner Dundalk Bay	1a	1a	2		Good
IE_SH_060_0800	Upper Shannon Estuary	1a	1a	2	5 - 14.9	Good
IE_SH_060_1100	Fergus Estuary	1a	1a	2		Good
IE_WE_160_0600	Lough Sallagh (Doorus Loughs)	1a	1a	2		Good
IE_WE_170_0700	Corrib Estuary	1a	1a	2		Good
IE_WE_470_0100	Garavoge Estuary	1a	1a	2		Good
IE_NB_030_0250	*Shilties Lough*	*1a*	*1a*	*2*		*High*
IE_SE_040_0400	*South Slob Channel*	*1a*	*1a*	*2*		*High*
IE_SH_060_1000	*Shannon Airport Lagoon*	*1a*	*1a*	*2*		*High*
IE_SW_170_0100	Inner Bantry Bay	1a	1a	2	0 - 4.9	High
IE_WE_170_0300	Ardfry Oyster Pool	1a	1a	2		High
IE_WE_170_0600	*Renmore Lough, Galway City*	*1a*	*1a*	*2*		*High*
IE_WE_190_0100	*Casla Estuary*	*1a*	*1a*	*2*		*High*
IE_WE_310_0100	Erriff Estuary	1a	1a	2		High
IE_WE_180_0100	Spiddal Estuary	2b	2b	3	15 - 29.9	Moderate
IE_SE_140_0200	Brickey Estuary	2b	2b	3	5 - 14.9	Good
IE_SW_190_0300	Inner Kenmare River	2b	2b	3		Good
IE_NW_160_0500	Meenaclady	2b	2a	3	0 - 4.9	High
IE_SW_230_0100	Cromane	2b	1b	3		High

	HIGH	GOOD	MOD	POOR	BAD
% Capacity Used	0 - 4.9	5 - 14.9	15 - 29.9	30 - 44.9	50 +

6.3.1 Results of Step 1

The following summarises the results of TraC-MImAS for those water bodies characterised as 'probably at risk' (1b) and 'probably not at risk' (2a) from morphology in the initial risk assessments. The results of this step as given in Tables 6.5 and 6.6 above, and also in Appendix 6-3, should be regarded as indicative in the absence of field trials and monitoring / classification results (refer to Section 6.1 and 6.2.1).

a) Of the 33 'probably at risk' (1b) water bodies assessed:

- 5 water bodies were estimated to be ***at risk of failing to achieve GES:***
  - Tramore Back Strand (SERBD)
  - Clonakilty Harbour (SWRBD)
  - Rogerstown Estuary (EARBD)
  - Rosscarbery Harbour (SWRBD)
  - Swilly Estuary (NWRBD)
- 17 water bodies were estimated to be ***at risk of failing to achieve HES***

b) Of the 44 'probably not at risk' (2a) water bodies assessed:

- 1 water body was estimated to be ***at risk of not achieving GES:***
  - Owenavorragh Estuary (SERBD)
- 8 water bodies were estimated to be ***at risk of failing to achieve HES***.

6.3.2 Results of Step 2

The following summarises the results of TraC-MImAS for those water bodies with potential to achieve GES or HES if morphology was restored or mitigated (i.e. water bodies for which an 'at risk' (1a) category was assigned for morphology pressures only). The results of this step are outline in Tables 6.5 and 6.6 above, and also in Appendix 6-3.

TraC-MImAS was applied to 27 'at risk' (1a) water bodies:

- 7 water bodies were estimated to be ***at risk of not achieving GES***:
  - Ballyteige Channels (SERBD)
  - Blanket Nook Lough (NWRBD)
  - Boyne Estuary (ERBD)
  - Duff Estuary (NWRBD)
  - Fane Estuary (NBRBD)
  - Glyde Estuary (NBRBD)
  - Inner Tralee Bay (ShIRBD)
- 16 water bodies were estimated to be ***at risk of failing to achieve HES***.

6.3.3 Results of Step 3

The following summaries the results of the assessment of TraC water bodies unlikely to be at risk of failing HES.

The application of Steps 1 and 2 further characterised the risk to those water bodies initially characterised as 'at risk' (1a), 'probably at risk' (1b), and 'probably not at risk' (2a) from morphology. Tables 6.5 and 6.6 identify which of these water bodies may have the potential to achieve HES.

All water bodies initially characterised as 'not at risk' (2b) were then reviewed to determine which of these may have the potential to achieve HES.

6.3.3.1 Further characterisation of risk for 'not at risk' (2b) water bodies

As noted in Step 3 in section 6.2.3 above, 18 'not at risk' (2b) water bodies required further assessment following the identification of potentially extensive pressure footprints. The results of this assessment using TraC-MImAS are outlined in Tables 6.5 and 6.6 above (MImAS Application Step 3).

- Of the 18 'not at risk' (2b) water bodies assessed, only 9 indicated ***a likelihood of achieving High Status***.

- Of the remaining 9 water bodies; 7 may potentially achieve GES, but TraC-MImAS results indicate a risk to the achievement of HES due to the extensive pressures identified. Table 6.7 below tabulates the pressure footprints identified for these water bodies.

- In addition, 2 water bodies, Berehaven (SWRBD) and Spiddal Estuary (WRBD), were estimated as being at risk of failing to achieve GES. The pressures identified for Berehaven and Spiddal Estuary are provided in detail in the appended Water Body Summary Sheets (Appendix 6-4).

Table 6.7: Pressure footprints identified for those water bodies characterised as 'not at risk' (2b) by the initial risk assessments

Water Body		Area (km^2)	Perimeter (km)	Pressure Footprints							
				Dredging - Low Impact (km^2)	Other Disturbances to Seabed (km^2)	Disposal (km^2)	Flow / Sediment Manipulation Structures (km^2)	Piled Structures (km^2)	Shoreline Reinforcement - High Impact (km)	Shoreline Reinforcement - Low Impact (km)	Embankments (km)
SE_140_0200	Brickey Estuary	0.63	9.11	0.05435	0	0	0	0	0	0	2.836
SH_040_0000	Outer Tralee Bay	215.81	111.56	31.18146	215.09630	1.57732	0.00019	0.00216	2.501	0.136	0.000
SW_100_0300	White's Marsh	0.03	1.11	0.00069	0	0	0	0	0	0	1.145
SW_170_0000	Outer Bantry Bay	276.18	182.70	139.94553	79.40766	0.04339	0.00576	0.00265	0.697	0	0
SW_190_0000	Outer Kenmare River	188.76	283.76	0	188.73803	0	0.00640	0.00015	1.778	0.709	0
SW_190_0300	Inner Kenmare River	3.79	28.41	0	3.78431	0	0.00123	0.00107	0.268	0	0
WE_420_0000	Killala Bay	81.38	68.05	8.74948	0	0	0.00405	0	0	0	0

6.3.3.2 Identification of water bodies unlikely to risk the achievement of HES

Following on from the further characterisation of ‘at risk’ (2b) water bodies with potentially extensive pressures, a review of all pressure footprints was undertaken to identify those water bodies for which no pressure footprints were identified.

Table 6.8 below lists 109 water bodies for which no pressure footprints were identified. The absence of morphological pressures indicates that the current morphological condition of these water bodies may be considered as ***unlikely to risk the achievement of HES***.

A qualitative review was then undertaken to identify any potential risks to the achievement of HES for the 109 water bodies.

Table 6.8: TraC water bodies for which no pressure footprints were identified

Water Body	TYPE	MImAS Assessment	Dredging / Channelisation	Deposition	Coastal Defence	Built Structures - Port Tonnage	Built Structures - Urban / Industrial Shoreline	Built structures - Power / Industrial Intakes	Intensive landuse	Morphology Overall Risk
NB_030_0250_Shilties Lough	TW6	Y	2b	2b	2b	2b		2b	1a	**1a**
SE_040_0400_South Slob Channel	TW6	Y	2b	2b	2b	2b		2b	1a	**1a**
SE_100_0250_Barrow Nore Estuary Upper	TW2		2b	2b	2b	1a		2b	1b	**1a**
SH_060_1000_Shannon Airport Lagoon	TW6	Y	2b	2b	2b	2b		2b	1a	**1a**
WE_170_0300_Ardfry Oyster Pool	TW6	Y	1a	2b	2b	2b			2b	**1a**
WE_170_0600_Renmore Lough, Galway City	TW6	Y	2b	2b	2b	2b			1a	**1a**
WE_190_0100_Casla Estuary	TW2	Y	2b	2b	2b	1a			2b	**1a**
NB_040_0200_Castletown Estuary	TW2		2a	2b	1b	2b		2b	1b	**1b**
NB_040_0300_Ballymascanlan Estuary	TW2	Y	2b	2b	1b	2b		2b	2b	**1b**
SE_040_0100_North Slob Channels	TW6	Y	2b	2b	2b	2b		2b	1b	**1b**
SE_070_0100_Tacumshin Lake	TW6	Y	2b	2b	2b	2b		2b	2a	**1b**
WE_390_0100_Tullaghan Bay	TW2	Y	2b	2b	2b	2b			1b	**1b**
WE_410_0100_Bunatrahir Bay	TW2	Y	2b	2b	2b	2b			1b	**1b**
NB_030_0200_Carlingford Lagoons	TW6		2b	2b	2b	2b		2b	2a	2a
NW_040_0100_Durnesh Lough	TW6	Y	2b	2b	2b	2b		2b	2a	2a
NW_140_0100_Maghery Lough	TW6	Y	2b	2b	2b	2b		2b	2a	2a
NW_160_0100_Loch Chionn Caslach (Kincas Lough)	TW6	Y	2b	2b	2b	2b		2b	2a	2a
NW_160_0300_Moorlagh	TW6	Y	2b	2b	2b	2b		2b	2a	2a
NW_180_0100_Loch O Dheas, Tory Island	TW6	Y	2b	2b	2b	2b		2b	2a	2a
NW_200_0200_Carrick Beg Lough (South)	TW6	Y	2b	2b	2b	2b		2b	2a	2a
SE_040_0300_Upper Slaney Estuary	TW2		2b	2b	2b	2b		2b	2a	2a
SE_060_0100_Lady's Island Lake	TW6	Y	2b	2b	2b	2b		2b	2a	2a
SE_090_0100_Corock Estuary	TW2	Y	2b	2b	2a	2b		2b	2b	2a
SE_100_0300_Upper Barrow Estuary	TW2		2b	2b	2a	2b		2b	2a	2a
SH_050_0200_Blennerville Lake East	TW6	Y	2b	2a	2b	2b		2b	2b	2a
SH_050_0300_Blennerville Lake West	TW6	Y	2b	2a	2b	2b		2b	2b	2a
SH_060_0400_Poulaweala Lough / Quayfield Lough	TW6	Y	2b	2a	2b	2b		2b	2b	2a
SH_090_0100_Lough Donnell	TW6		2b	2a	2b	2b		2b	2b	2a
SH_110_0100_Aille Clare Estuary	TW2	Y	2b	2a	2b	2b		2b	2b	2a
SW_020_0500_Upper Blackwater M Estuary	TW2		2b	2b	2a	2b		2b	2b	2a
SW_060_0600_Slatty Bridge, Fota Island	TW6		2b	2b	2a	2b		2b	2b	2a
WE_350_0300_Furnace Lough	TW6	Y	2b	2b	2b	2b			2a	2a
WE_440_0100_Easky Estuary	TW2	Y	2b	2b	2b	2b			2a	2a
EA_040_0000_Rockabill	CW5		2b	2b	2b	2b	2b	2b		2b
NB_040_0600_Corstown Lagoon	TW6		2b	2b	2b	2b		2b	2b	2b
NW_020_0100_Drowes Estuary	TW2		2b	2b	2b	2b		2b	2b	2b
NW_130_0000_Trawena Bay	CW8		2b	2b	2b	2b	2b	2b	2b	2b
NW_150_0100_Sally's Lough	CW10		2b	2b	2b	2b	2b	2b	2b	2b
NW_190_0100_Lackagh Estuary	TW2		2b	2b	2b	2b		2b	2b	2b
SE_100_0400_Nore Estuary	TW2		2b	2b	2b	2b		2b	2b	2b
SE_130_0100_Mahon Estuary	TW2		2b	2b	2b	2b		2b	2b	2b
SH_060_1300_Scattery Island Lagoon	CW10		2b	2b	2b	2b	2b	2b	2b	2b
SH_060_1400_Clonconeen Pool	CW10		2b	2b	2b	2b	2b	2b	2b	2b
SW_020_0400_Lackaroe (Glendine Estuary)	TW6		2b	2b	2b	2b		2b	2b	2b
SW_060_0100_Rostellan Lake	TW6		2b	2b	2b	2b		2b	2b	2b
SW_060_0200_Cuskinny Lake	TW6		2b	2b	2b	2b		2b	2b	2b
SW_060_1000_Raffeen Lake, Shanbally	CW10		2b	2b	2b	2b	2b	2b	2a	2b
SW_060_1100_Lough Beg / Curraghbinny	TW6		2b	2b	2b	2b			2b	2b
SW_070_0200_Oysterhaven Lake, Clashroe	TW6		2b	2b	2b	2b		2b	2b	2b
SW_080_0200_Kinsale Marsh, Commoge	CW10		2b	2b	2b	2b	2b	2b	2a	2b
SW_080_0300_Upper Bandon Estuary	TW2		2b	2b	2b	2b		2b	2b	2b
SW_100_0200_Inchydoney	CW10		2b	2b	2b	2b	2b	2b	2a	2b
SW_110_0100_Kilkeran Lake	TW6		2b	2b	2b	2b		2b	2b	2b
SW_120_0000_Fastnet Waters	CW2		2b	2b	2b	2b	2b	2b		2b
SW_140_0100_Ballyrisode Bridge Lagoon	CW10		2b	2b	2b	2b	2b	2b	2a	2b
SW_150_0100_Reen Point Pool	TW6		2b	2b	2b	2b		2b	2b	2b
SW_160_0100_Farranamagh Lough	TW6		2b	2b	2b	2b		2b	2b	2b
SW_170_0200_Kilmore Lake, Whiddy Island	TW6		2b	2b	2b	2b		2b	2b	2b
SW_170_0300_Reenydonagan Lough	TW6		2b	2b	2b	2b		2b	2b	2b
WE_020_0100_Loch Mor, Inis Oirr	TW6		2b	2b	2b	2b			2b	2b
WE_030_0100_Port na Cora lochs, Inis Meain	TW6		2b	2b	2b	2b			2b	2b
WE_040_0100_Loch na gCadhan, Inis Meain	TW6		2b	2b	2b	2b			2b	2b
WE_050_0100_Loch an tSaile, Arainn	TW6		2b	2b	2b	2b			2b	2b
WE_055_0100_Baile an Duin Lagoon	TW6		2b	2b	2b	2b			2b	2b
WE_060_0100_Loch an Chara, Arainn	TW6		2b	2b	2b	2b			2b	2b
WE_070_0100_Loch Phort Chorruch, Arainn	TW6		2b	2b	2b	2b			2b	2b

Table 6.8 continued: TraC water bodies for which no pressure footprints were identified

Water Body	TYPE	MImAS Assessment	Dredging / Channelisation	Deposition	Coastal Defence	Built Structures - Port Tonnage	Built Structures - Urban / Industrial Shoreline	Built structures - Power / Industrial Intakes	Intensive landuse	Morphology Overall Risk
WE_080_0100_Loch Dearg, Arainn	TW6		2b	2b	2b	2b			2b	2b
WE_090_0100_Loch Amurvy, Arainn	TW6		2b	2b	2b	2b			2b	2b
WE_110_0100_Muckinish Lough	TW6		2b	2b	2b	2b			2b	2b
WE_120_0100_Murree Lough	TW6		2b	2b	2b	2b			2b	2b
WE_140_0100_Aughinish Lagoon	TW6		2b	2b	2b	2b			2b	2b
WE_140_0200_Carrownahallia Lagoon, Aughinish	TW6		2b	2b	2b	2b			2b	2b
WE_150_0100_Rossalia Lagoon	TW6		2b	2b	2b	2b			2b	2b
WE_160_0300_Loughaungreena (Doorus Loughs)	TW6		2b	2b	2b	2b			2b	2b
WE_160_0400_Lough Fadda (Doorus Loughs)	TW6		2b	2b	2b	2b			2b	2b
WE_160_0500_Lough Namona (Doorus Loughs)	TW6		2b	2b	2b	2b			2b	2b
WE_160_0700_Rincarna Pools South	CW10		2b	2b	2b	2b	2b	2b	2b	2b
WE_160_0710_Rincarna Pools North	CW10		2b	2b	2b	2b	2b	2b	2b	2b
WE_170_0150_Mweeloon Pool North	TW6		2b	2b	2b	2b			2b	2b
WE_170_0200_Loughaunascalia, Ardfry Point	TW6		2b	2b	2b	2b			2b	2b
WE_170_0400_Turreen Lough (Rinville West)	TW6		2b	2b	2b	2b			2b	2b
WE_190_0200_Lough Faddacrussan	TW6		2b	2b	2b	2b			2b	2b
WE_200_0300_Loch Fhada Upper Pools	TW6		2b	2b	2b	2b			2b	2b
WE_200_0400_Loch an Ghadai	TW6		2b	2b	2b	2b			2b	2b
WE_200_0500_Loch Fhada	TW6		2b	2b	2b	2b			2b	2b
WE_200_0600_Loch Tanai	TW6		2b	2b	2b	2b			2b	2b
WE_200_0800_Loch Cara Fionnla	TW6		2b	2b	2b	2b			2b	2b
WE_200_1000_Loch Doire Bhanbh (Derravonniff)	TW6		2b	2b	2b	2b			2b	2b
WE_200_1100_Loch an tSaile, North of Camus Bay	TW6		2b	2b	2b	2b			2b	2b
WE_200_1200_Loch Conaortha (L. Aconeera)	TW6		2b	2b	2b	2b			2b	2b
WE_210_0100_Loch an Chaorain (L. Keeraun)	TW6		2b	2b	2b	2b			2b	2b
WE_220_0100_Lough an Mhuilinn (Mill Lough)	TW6		2b	2b	2b	2b			2b	2b
WE_240_0100_Ballyconneely Lough	TW6		2b	2b	2b	2b			2b	2b
WE_260_0100_Loch an tSaile (Lough Athola)	TW6		2b	2b	2b	2b			2b	2b
WE_280_0100_Lough B-Finne, Inishbofin	TW6		2b	2b	2b	2b		2b	2b	2b
WE_290_0100_Lough Anillaun, Cleggan Bay	TW6		2b	2b	2b	2b			2b	2b
WE_320_0100_Corragaun Lough	TW6		2b	2b	2b	2b			2b	2b
WE_330_0100_Roonagh Lough	TW6		2b	2b	2b	2b			2b	2b
WE_370_0100_Dooniver Loughs	TW6		2b	2b	2b	2b			2b	2b
WE_380_0000_Bellacragher Bay	CW8		2b	2b	2b	2b	2b	2b		2b
WE_405_0000_Belmullet Bay	CW8		2b	2b	2b	2b	2b	2b		2b
WE_420_0100_Cloonaghmore Estuary	TW2		2b	2b	2b	2b			2b	2b
WE_420_0200_Cartoon Lough, Killala Bay	CW10		2b	2b	2b	2b	2b	2b	2b	2b
WE_460_0000_Ballysadare Bay	CW8		2b	2b	2b	2b	2b	2b		2b
WE_460_0100_Portavaud West, Ballysadare Bay	TW6		2b	2b	2b	2b			2b	2b
WE_460_0200_Portavaud East, Ballysadare Bay	CW10		2b	2b	2b	2b	2b	2b	2b	2b
WE_460_0300_Ballysadare Estuary	TW2		2b	2b	2b	2b			2b	2b
WE_460_0400_Tanrego Intake	TW6		2b	2b	2b	2b			2b	2b
WE_480_0100_Drumcliff Estuary	TW2		2b	2b	2b	2b			2b	2b

6.3.3.3 Further characterisation of potential risks to the achievement of HES

Of the 109 water bodies with no identified pressure footprints, 13 were initially characterised as ‘at risk’ (1a) or ‘probably at risk’ (1b) from physical alterations. This warranted further assessment of these water bodies as the results of TraC-MImAS (applied in Steps 1 and 2) indicated that these water bodies could potentially achieve HES (Table 6.5 and 6.6). Details of these water bodies are summarised below.

It is important to note that new pressure footprints were only digitised in areas of orthophoto coverage (refer to Section 3.2.1.7 of Chapter 3). The results table in Appendix 6-3 identifies those water bodies for which orthophotos were unavailable.

i **Ardfry Oyster Pool (WRBD):** this water body was reported by the initial risk assessments as ‘at risk’ due to channelisation. However, following a review of OPW data and orthophotos no evidence of channelisation was identified. In the absence of further baseline information, it is considered ***likely that this water body can achieve GES.***

ii **Casla Estuary (WRBD):** A category of ‘at risk’ was assigned to Casla Estuary for the pressure ‘Built Structures (port tonnage)’. No port infrastructure associated with this water body was identified. Therefore, in the absence of further baseline information, it is considered ***likely that this water body can achieve GES.***

iii **Ballymascanlan Estuary (NBRBD):** The initial risk assessments predicted that this water body was ‘probably not at risk’ from coastal defence. OPW data relating to embankments did not extend to this water body and lack of orthophotos for this area prevented digitising of pressure footprints. A review of orthophotos via the EPA’s online interactive map, ENVision, indicated that the majority of this water body’s shoreline is embanked. As an estimation of risk, the full length of this water body’s shoreline (12.7 km) was assigned to intertidal embankments within TraC-MImAS. Table 6.9 below shows that Ballymascanlan Estuary is ***potentially at risk of failing to meet GES.***

Table 6.9: Percentage capacity used by flood embankments within Ballymascanlan Estuary; estimation based on embankment of the total length of intertidal shoreline

TOTAL CAPACITY USED		
Hydrodynamics	0.0%	HIGH
Intertidal Zone	16.7%	MOD
Subtidal Zone	0.0%	N/A

iv **Tacumshin Lake (SERBD):** This water body was characterised as 'probably not at risk' due to impoundment. A review of the historic maps and oblique images indicated that the impoundment of this water body is attributed to natural deposition of material which has created a barrier of dunes. Figure 6.1 below conveys where, historically, flow exchange was permitted between this water body and the Eastern Celtic Sea. Although this area is now barred with dunes the lagoon is known to breach during storm conditions (and therefore partially saline). Tacumshin Lake is designated as a SAC and bird sanctuary. The CFB notes that farmers use sluice gates to provide a minimum water level in the lake, and that this lake is an extremely poor habitat for fish (CFB/Marine Institute, 2006). This is associated with the fact that there is no breach that would allow recruitment of fish, and that "lack of tidal flushing or any significant freshwater inputs means that eutrophic conditions prevail in the summer contributing to fish kills" (CFB/Marine Institute, 2006).

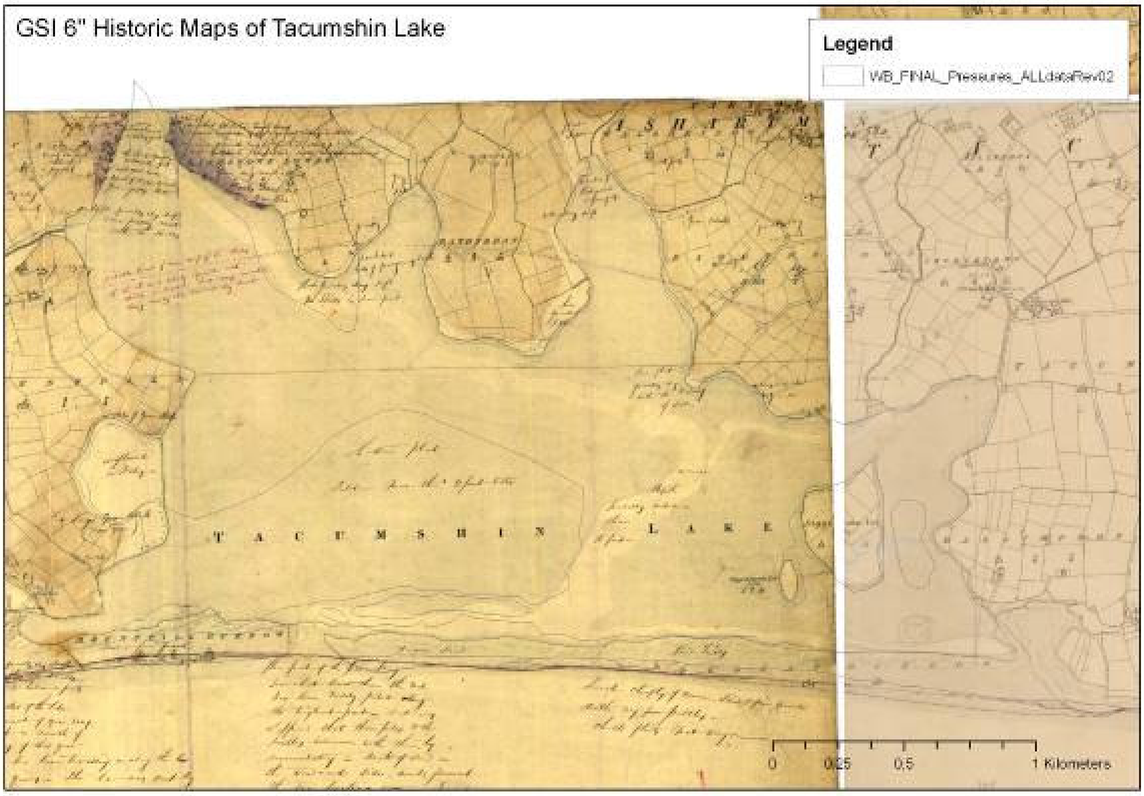


Figure 6.1: Historic bedrock geology maps of Tacumshin Lake

In the absence of further baseline information, the existing ***risk associated with morphological alterations for Tacumshin Lake cannot be concluded.***

The following sections summarise those remaining 9 water bodies identified as containing no pressure footprints. These 9 water bodies were characterised in the initial risk assessments as being ‘at risk’ or ‘probably at risk’ due to intensive land use.

An assessment of adjacent land use is not a component of TraC-MImAS, which considers for the most part engineering pressures. The WRBD is undertaking an assessment of intensive land use associated with forestry and peat lands, therefore, it is recommended that in addition to the summaries below, the results of the WRBD PoMS studies should be considered prior to classification of water bodies subject to intensive land use associated with forestry and peat lands. Table 6.10 below, summarises the proportion of TraC water body shoreline flanked with non-irrigated arable land, exploited peat bog, coniferous forest, and urban, industrial and transport related land uses. As noted in Chapters 3 and 5 of this report, the pressure of intensive land use associated with urban, industrial and transport related land uses is considered by TraC-MImAS via the assessment of pressures such as shoreline reinforcement, flow and sediment manipulation structures and land claim.

v **Castletown Estuary (NBRBD):** This water body was considered at risk from coastal defence features as well as intensive land use. Lack of orthophotos for this water body prevented digitising of pressure footprints. However, a review of the EPA's ENVision interactive map has identified that a significant proportion of this water body's shoreline is reinforced and embanked. The shoreline is flanked by industrial, urban and agricultural related land uses and the water body is crossed by 3 piled bridges. The CFB/Marine Institute (2006) have identified that the main channel is regularly dredged for navigational purposes and outside of this channel, intertidal area makes up a "substantial component of the estuary", some of which contains saltmarsh, and has a predominant bed type of mud. The lower estuary is considered by the CFB to be of importance as a "nursery ground for juvenile flatfish as well as juvenile gadoids such as cod" (CFB/Marine Institute, 2006). The pressure footprints for this water body should be identified for assessment using TraC-MImAS, as it is likely that Castletown Estuary is ***at risk of achieving HES.***

vi **Renmore Lough (WRBD):** At present this water body is not subject to significant physical alterations. However, adjacent land use associated with the harbour indicates future pressure on this water body, possibly associated with land reclamation. In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

vii **Shilities Lough (NBRBD):** Orthophotos indicate that this water body may be partially infilled and in close proximity to recent housing developments. The origin of this water body and source of seawater should be investigated further before the risk of this water body failing to achieve the WFD objectives can be determined. In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

Not far from Shilities Lough are the Carlingford Lagoons which were not considered 'at risk' in the initial risk assessments. However, these lagoons are part of the Greenore Golf Course, and considered to be artificially maintained, and therefore unlikely to of HES. In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

viii **South Slob Channel (SERBD):** The CMRC, using information obtained from a study titled 'Wetlands of Ireland: Distribution, Ecology and Economic Value' (Otte, 2003) digitised the location of coastal lagoons within the RoI. This water body was identified as an artificial drainage channel which received seawater via percolation (and possibly an inlet). Therefore, it is considered likely that this water body is ***at risk of failing to achieve HES.***

ix **North Slobs Channels (SERBD):** As with the South Slob Channel, these channels were identified as artificial drainage lagoons, again questioning the ability of these channels to achieve HES. Therefore, it is considered likely that this water body is ***at risk of failing to achieve HES.***

x **Shannon Airport Lagoon (ShIRBD):** Figure 6.2 below indicates that this lagoon has been created by reclamation at Shannon Airport. However, the definition of an artificial water body in the WFD does not permit water bodies such as this to be classed as such. The estuary surrounding the lagoon is an SPA (Site Code 004077), and the lagoon is part of an SAC (Site Code: 002165).

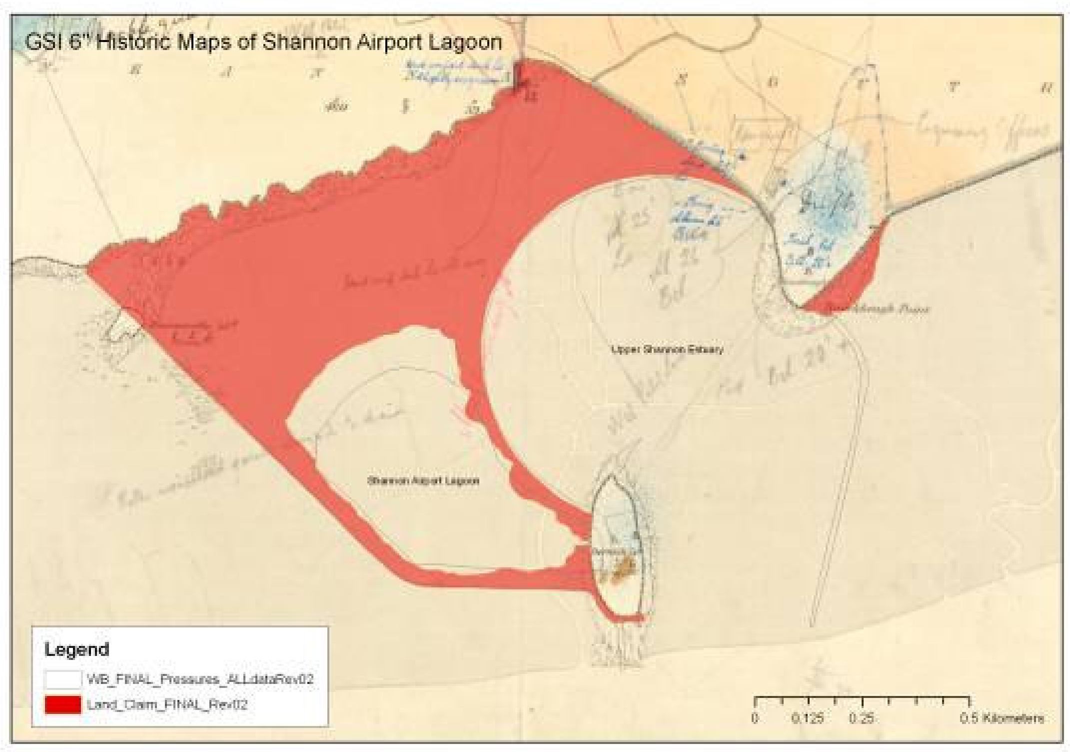


Figure 6.2: Historic bedrock geology maps of Upper Shannon Estuary and estimated are of reclamation surrounding the existing Shannon Airport Lagoon.

In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

xi **Barrow Nore Estuary Upper (SERBD):** orthophotos were unavailable to digitise pressures within this water body. Using the EPA ENVision online interactive map, a limited amount of shoreline reinforcement is evident in the downstream reaches of the estuary as well as piled structures. The surrounding land use consists of arable land; however, much of this is buffered by narrow areas of woodland. Detailed assessment of pressure footprints within this water body is required before a risk category can be assigned. In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

xii **Tullaghan Bay (WRBD):** The exploitation of peat adjacent to this water body triggered its characterisation as 'probably at risk'. It is considered that this activity, which is estimated to have extended over 6% of the bay's shoreline has now ceased. The majority of this bay is unvegetated bare sand and is considered to be 'pristine with only limited agricultural activity and a few houses around the estuary' (CFB, 2006). In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

xiii **Bunatrahir Bay (WRBD):** Areas identified as exploited peat bog appear to be concentrated near to the rocky shores of this bay. Some arable land lies adjacent to the sandy shore at the estuary's inlet. However, there is no indication of extensive pressures associated with this land. In the absence of further baseline information, the existing ***risk associated with morphological alterations cannot be concluded.***

Table 6.10: Summary of percentage shoreline of TraC water bodies flanked with intensive land use

Waterbody Name and Code	Waterbody Perimeter (Km)	Intensive Land Use Arable (%)	Coniferous (%)	Peat Bog (%)	Industrial (%)	Transport (%)	Urban (%)
EA_010_0100_Boyne Estuary	43.47	2.87	0.00	0.00	0.00	0.00	19.74
EA_020_0000_Northwestern Irish Sea (HA 08)	47.58	32.76	0.00	0.00	0.00	0.00	15.24
EA_030_0100_Nanny Estuary	8.96	15.72	0.00	0.00	0.00	0.00	10.49
EA_050_0100_Rogerstown Estuary	19.31	38.73	0.00	0.00	0.00	0.00	6.01
EA_060_0000_Malahide Bay	10.56	12.30	0.00	0.00	0.00	0.00	3.89
EA_060_0100_Broadmeadow Water	11.34	31.62	0.00	0.00	3.55	0.00	17.71
EA_070_0000_Irish Sea Dublin (HA 09)	19.80	5.51	0.00	0.00	0.00	15.94	18.35
EA_080_0100_Mayne Estuary	9.13	7.19	0.00	0.00	0.00	0.00	12.37
EA_090_0000_Dublin Bay	39.80	0.00	0.00	0.00	0.25	24.61	44.34
EA_090_0100_North Bull Island	8.38	0.00	0.00	0.00	0.00	0.00	46.14
EA_090_0200_Tolka Estuary	16.44	0.00	0.00	0.00	17.22	0.00	43.53
EA_090_0300_Liffey Estuary Lower	20.23	0.00	0.00	0.00	3.79	66.88	9.21
EA_090_0400_Liffey Estuary Upper	9.09	0.00	0.00	0.00	0.00	0.00	100.00
EA_100_0000_Southwestern Irish Sea - Killiney Bay (HA10)	50.86	2.27	0.00	5.04	0.00	1.70	14.15
EA_110_0100_Dargle Estuary	0.75	0.00	0.00	0.00	0.00	0.00	54.90
EA_120_0100_Kilcoole Marsh	19.57	0.00	0.00	0.00	0.00	0.00	0.00
EA_130_0100_Broad Lough	14.64	0.00	0.00	0.00	0.00	17.69	10.47
EA_140_0000_Southwestern Irish Sea - Brittas Bay (HA 10)	26.29	5.23	0.00	0.00	0.00	1.64	2.71
EA_150_0100_Avoca Estuary	5.60	0.00	0.00	0.00	0.00	41.95	39.92
GBNIIE6NB020_Mourne Coast	25.95	5.60	0.00	0.00	0.00	0.00	0.00
NB_010_0000_Portstewart Bay	36.33	0.00	0.00	0.00	0.00	0.00	2.55
NB_025_0000_Louth Coast (HA 06)	19.59	44.97	0.00	0.00	0.00	0.00	0.00
NB_030_0000_Carlingford Lough	42.41	1.17	0.83	0.00	0.00	0.00	26.11
NB_030_0100_Newry Estuary	24.62	0.00	0.00	0.00	10.68	0.00	8.04
NB_030_0250_Shilties Lough	0.30	100.00	0.00	0.00	0.00	0.00	0.00
NB_040_0000_Outer Dundalk Bay	23.19	40.65	0.00	0.00	0.00	0.00	0.00
NB_040_0100_Inner Dundalk Bay	20.92	1.64	0.00	0.00	0.00	0.00	25.68
NB_040_0200_Castletown Estuary	13.68	0.00	0.00	0.00	0.00	0.00	53.15
NB_040_0300_Ballymascanlan Estuary	12.39	6.33	0.00	0.00	0.00	0.00	0.00
NB_040_0400_Fane Estuary	8.37	70.50	0.00	0.00	0.00	0.00	11.29
NB_040_0500_Glyde Estuary	9.28	77.78	0.00	0.00	0.00	0.00	0.00
NW_010_0000_Donegal Bay (Erne)	64.42	0.00	0.14	0.00	0.00	0.00	1.94
NW_020_0000_Bundoran Bay	5.58	0.00	0.00	0.00	0.00	0.00	50.71
NW_020_0100_Drowes Estuary	1.03	0.00	0.00	0.00	0.00	0.00	33.02
NW_030_0100_Erne Estuary	11.83	0.00	0.00	0.00	0.00	0.00	12.52
NW_050_0100_Inner Donegal Bay	41.55	0.00	5.02	0.00	0.00	0.00	5.68
NW_060_0000_Inver Bay	13.41	0.00	0.00	5.90	0.00	0.00	0.00
NW_085_0000_Killybegs Harbour	14.14	0.00	0.00	0.00	0.00	0.00	25.85
NW_110_0100_Owenea Estuary	29.19	0.00	0.00	6.90	0.00	0.00	0.00
NW_120_0100_Gweebarra Estuary	44.09	0.00	5.45	0.00	0.00	0.00	0.00
NW_130_0000_Trawena Bay	24.87	0.00	0.00	3.13	0.00	0.00	0.00
NW_140_0000_Dungloe Bay	27.46	0.00	0.00	0.00	0.00	0.00	2.93
NW_170_0000_Ballyness Bay	23.63	0.00	0.00	0.00	0.00	0.00	5.11
NW_190_0000_Sheephaven Bay	65.45	1.42	1.00	1.07	0.00	0.00	2.80
NW_190_0100_Lackagh Estuary	9.23	38.20	0.00	0.00	0.00	0.00	0.00
NW_200_0000_Mulroy Bay Broadwater	88.11	1.92	3.34	2.34	0.00	0.00	0.00
NW_210_0000_Mulroy Bay Northwater	25.70	8.12	0.00	15.17	0.00	0.00	0.00
NW_220_0000_Lough Swilly	77.99	0.00	0.00	5.70	0.00	0.00	0.00
NW_220_0100_Swilly Estuary	96.12	9.83	0.00	0.00	0.00	0.00	7.85
NW_220_0200_Blanket Nook Lough	4.68	0.57	0.00	0.00	0.00	0.00	0.00
NW_220_0300_Inch Lough	10.56	22.54	0.00	0.00	0.00	0.00	0.00
NW_220_0400_Crana Estuary	4.55	0.00	0.00	0.00	0.00	0.00	57.05
NW_230_0000_Northern Atlantic Seaboard (HAs 40;02)	99.95	0.48	0.00	22.21	0.00	0.00	0.56
NW_250_0000_Lough Foyle	54.31	0.00	0.00	0.00	0.00	0.00	0.96
NW_250_0100_Foyle and Faughan Estuaries	115.12	12.33	0.00	0.00	0.00	0.00	1.25
SE_010_0000_Southwestern Irish Sea (HAs 11;12)	64.30	4.64	1.22	0.00	0.00	3.39	9.24
SE_020_0100_Owenavorragh Estuary	4.07	0.00	0.00	0.00	0.00	0.00	31.57
SE_040_0000_Wexford Harbour	16.61	40.81	9.02	0.00	0.00	0.00	0.00
SE_040_0100_North Slob Channels	11.22	45.36	0.00	0.00	0.00	0.00	0.00
SE_040_0200_Lower Slaney Estuary	54.47	16.23	0.00	0.00	0.00	0.00	8.67
SE_040_0300_Upper Slaney Estuary	17.91	5.63	0.00	0.00	0.00	0.00	14.72
SE_040_0400_South Slob Channel	5.58	92.00	0.00	0.00	0.00	0.00	0.00
SE_045_0000_Rosslare Harbour	1.48	0.00	0.00	0.00	0.00	75.48	24.52
SE_050_0000_Eastern Celtic Sea (HAs 13;17)	142.36	15.68	0.00	0.00	0.00	0.00	0.94
SE_060_0100_Lady's Island Lake	15.49	18.63	0.00	0.00	0.00	0.00	0.00
SE_070_0100_Tacumshin Lake	17.27	13.47	0.00	0.00	0.00	0.00	0.00
SE_080_0100_Bridgetown Estuary	17.70	30.96	0.00	0.00	0.00	0.00	0.00
SE_080_0200_Ballyteige Channels	10.58	51.20	0.00	0.00	0.00	0.00	0.00
SE_090_0000_Bannow Bay	27.93	46.47	0.00	0.00	0.00	0.00	0.00
SE_090_0100_Corock Estuary	9.98	8.12	0.00	0.00	0.00	0.00	0.00
SE_100_0000_Waterford Harbour	22.05	36.18	0.00	0.00	0.00	0.00	10.31
SE_100_0100_Barrow Suir Nore Estuary	40.26	20.69	0.00	0.00	0.00	0.00	6.29

Table 6.10 continued: Summary of percentage shoreline of TraC water bodies flanked with intensive land use

Waterbody Name and Code	Waterbody Perimeter (Km)	Intensive Land Use					
		Arable (%)	Coniferous (%)	Peat Bog (%)	Industrial (%)	Transport (%)	Urban (%)
SE_100_0200_New Ross Port	39.21	10.05	0.00	0.00	7.36	0.00	4.16
SE_100_0250_Barrow Nore Estuary Upper	8.65	0.00	0.00	0.00	0.00	0.00	31.41
SE_100_0300_Upper Barrow Estuary	33.89	7.97	5.04	0.00	0.00	0.00	0.00
SE_100_0400_Nore Estuary	31.88	0.92	0.92	0.00	0.00	0.00	0.00
SE_100_0500_Lower Suir Estuary	22.02	13.54	0.58	0.00	3.21	0.00	22.01
SE_100_0550_Middle Suir Estuary	63.49	10.58	0.00	0.00	0.00	0.00	12.60
SE_100_0600_Upper Suir Estuary	24.43	0.00	1.07	0.00	0.00	0.00	20.19
SE_110_0000_Tramore Bay	12.40	0.00	0.00	0.00	0.00	0.00	23.92
SE_120_0000_Tramore Back Strand	21.29	15.16	0.00	0.00	0.00	0.00	1.34
SE_140_0000_Dungarvan Harbour	15.56	5.00	0.00	0.00	0.00	0.00	0.00
SE_140_0100_Colligan Estuary	30.82	7.75	0.00	0.00	0.00	0.00	14.67
SE_140_0200_Brickey Estuary	8.60	7.78	0.00	0.00	0.00	0.00	0.00
SH_010_0000_Southwestern Atlantic Seaboard (HA 23)	54.42	0.00	0.00	0.67	0.00	0.00	0.00
SH_020_0000_Smerwick Harbour	23.58	0.00	0.00	0.00	0.00	0.00	2.08
SH_030_0000_Brandon Bay	30.80	3.83	0.00	0.00	0.00	0.00	0.00
SH_040_0000_Outer Tralee Bay	82.71	7.90	0.00	1.06	0.00	0.00	1.91
SH_050_0000_Inner Tralee Bay	21.24	0.00	0.00	0.00	0.00	0.00	9.84
SH_060_0000_Mouth of the Shannon (HAs 23;27)	151.25	1.03	0.00	2.31	0.00	0.00	3.48
SH_060_0300_Lower Shannon Estuary	132.08	1.30	0.00	0.00	5.41	1.15	1.16
SH_060_0350_Foynes Harbour	2.24	0.00	0.00	0.00	81.86	0.00	0.00
SH_060_0600_Deel Estuary	16.72	14.64	0.00	0.00	9.60	0.00	6.78
SH_060_0700_Maigue Estuary	42.23	11.55	0.00	0.00	0.00	0.00	0.30
SH_060_0800_Upper Shannon Estuary	67.15	5.69	0.00	0.00	3.44	2.14	1.19
SH_060_0900_Limerick Dock	37.51	0.00	0.00	0.00	6.62	0.00	45.14
SH_060_1000_Shannon Airport Lagoon	1.82	0.00	0.00	0.00	12.26	87.74	0.00
SH_060_1100_Fergus Estuary	98.45	0.44	0.00	0.00	0.00	0.00	0.98
SH_070_0000_Shannon Plume (HAs 27;28)	138.32	0.00	0.00	4.84	0.00	0.00	1.86
SH_100_0000_Liscannor Bay	22.30	0.00	0.00	0.00	0.00	0.00	15.70
SH_100_0100_Inagh Estuary	18.90	2.77	0.00	0.00	0.00	0.00	7.36
SW_010_0000_Western Celtic Sea (HAs 18;19;20)	99.18	21.51	0.00	0.00	0.00	0.00	0.33
SW_020_0000_Youghal Bay	26.15	37.89	0.00	0.00	0.00	0.04	5.16
SW_020_0100_Lower Blackwater M Estuary / Youghal Harbour	92.10	7.51	1.34	0.00	0.00	1.63	1.83
SW_020_0500_Upper Blackwater M Estuary	15.81	3.61	0.00	0.00	0.00	0.00	4.80
SW_030_0100_Womanagh Estuary	20.23	12.31	0.00	0.00	0.00	0.00	0.00
SW_040_0000_Ballycotton Bay	21.37	27.77	0.00	0.00	0.00	0.00	7.47
SW_050_0000_Outer Cork Harbour	31.63	34.00	0.00	0.00	1.93	0.00	0.00
SW_060_0000_Cork Harbour	48.98	8.51	0.00	0.00	11.56	11.80	22.31
SW_060_0100_Rostellan Lake	2.13	0.00	0.00	0.00	0.00	0.00	11.41
SW_060_0300_North Channel Great Island	36.60	15.91	0.00	0.00	0.00	0.00	0.00
SW_060_0400_Owenacurra Estuary	12.98	17.52	0.00	0.00	0.00	0.00	32.38
SW_060_0700_Lough Mahon (Harper's Island)	15.83	12.44	0.00	0.00	0.00	0.00	7.51
SW_060_0750_Lough Mahon	48.84	1.81	0.00	0.00	6.48	5.30	33.98
SW_060_0800_Glashaboy Estuary	4.45	0.00	0.00	0.00	0.00	5.97	55.52
SW_060_0900_Lee (Cork) Estuary Lower	10.35	0.00	0.00	0.00	0.00	33.75	66.25
SW_060_0950_Lee (Cork) Estuary Upper	14.17	0.00	0.00	0.00	0.00	0.00	97.71
SW_060_1200_Owenboy Estuary	18.85	12.81	0.00	0.00	0.00	0.00	32.53
SW_070_0100_Oysterhaven	28.42	26.16	0.00	0.00	0.00	0.00	0.00
SW_070_0200_Oysterhaven Lake, Clashroe	1.21	0.00	0.00	0.00	0.00	0.00	0.00
SW_080_0000_Kinsale Harbour	20.63	32.64	0.00	0.00	0.00	0.00	0.00
SW_080_0100_Lower Bandon Estuary	47.67	15.59	0.00	0.00	0.00	3.79	3.84
SW_080_0200_Kinsale Marsh, Commoge	0.92	0.00	0.00	0.00	0.00	0.00	0.00
SW_080_0300_Upper Bandon Estuary	8.08	2.17	0.00	0.00	0.00	0.00	6.26
SW_090_0000_Courtmacsherry Bay	39.55	12.88	0.00	0.00	0.00	0.00	0.00
SW_090_0200_Argideen Estuary	24.03	9.57	0.00	0.00	0.00	0.00	9.24
SW_100_0000_Clonakilty Bay	32.99	9.58	0.00	0.00	0.00	0.00	0.00
SW_100_0100_Clonakilty Harbour	10.13	5.90	0.00	0.00	0.00	0.00	14.63
SW_110_0000_Rosscarbery Bay	66.44	0.00	0.00	0.00	0.00	0.00	0.87
SW_110_0200_Rosscarbery Harbour	2.00	0.00	0.00	0.00	0.00	0.00	60.82
SW_110_0300_Glandore Harbour	19.33	4.66	0.00	0.00	0.00	0.00	0.00
SW_130_0100_Ilen Estuary	42.04	0.25	0.00	0.00	0.00	0.00	12.67
SW_140_0000_Roaring Water Bay	125.95	0.00	0.00	0.00	0.00	0.00	1.51
SW_150_0000_South Western Atlantic Seaboard (HAs 21;22)	138.87	0.00	0.00	0.72	0.00	0.00	0.00
SW_170_0000_Outer Bantry Bay	122.68	0.00	0.00	6.47	0.00	2.98	0.00
SW_170_0100_Inner Bantry Bay	30.36	0.00	0.00	0.00	0.00	0.00	2.17
SW_180_0000_Berehaven	29.80	0.00	4.30	0.00	0.00	0.00	18.24
SW_190_0000_Outer Kenmare River	178.97	0.00	0.00	2.72	0.00	0.00	0.00
SW_190_0100_Ardgroom	16.69	0.00	0.00	0.00	0.00	0.00	0.00
SW_190_0200_Kilmakilloge Harbour	31.99	0.00	0.00	4.17	0.00	0.00	0.00
SW_190_0300_Inner Kenmare River	23.75	0.00	0.00	12.19	0.00	0.00	5.42
SW_190_0500_Drongawn Lough, Sneem	2.35	0.00	0.00	43.53	0.00	0.00	0.00
SW_200_0000_Ballinskelligs Bay	45.67	0.00	0.00	0.00	0.00	0.00	1.69
SW_210_0000_Portmagee Channel	24.16	0.00	0.00	6.66	0.00	0.00	0.00
SW_220_0100_Ferta	17.51	0.00	0.00	2.27	0.00	0.00	6.49
SW_230_0000_Outer Dingle Bay	122.72	0.00	0.00	6.75	0.00	0.00	0.00
SW_230_0200_Castlemaine Harbour	61.46	0.00	0.00	0.42	0.00	0.00	2.44
SW_240_0000_Dingle Harbour	14.69	0.00	0.00	0.00	0.00	0.00	19.81

Table 6.10 continued: Summary of percentage shoreline of TraC water bodies flanked with intensive land use

Waterbody Name and Code	Waterbody Perimeter (Km)	Intensive Land Use					
		Arable (%)	Coniferous (%)	Peat Bog (%)	Industrial (%)	Transport (%)	Urban (%)
WE_010_0000_Aran Islands, Galway Bay, Connemara (HAs 29;31)	101.74	0.00	0.00	2.65	0.00	0.00	0.23
WE_110_0000_Ballyvaghan Bay	28.77	13.29	0.00	0.00	0.00	0.00	0.00
WE_130_0000_Aughinish Bay	30.30	16.21	0.00	0.00	0.00	0.00	0.00
WE_160_0800_Dunbulcaun Bay	16.71	8.69	0.00	0.00	0.00	0.00	0.00
WE_170_0000_Inner Galway Bay North	40.15	0.00	0.00	0.00	0.00	0.00	11.67
WE_170_0600_Renmore Lough, Galway City	0.79	0.00	0.00	0.00	0.00	0.00	100.00
WE_170_0700_Corrib Estuary	16.28	0.00	0.00	0.00	0.00	0.00	59.15
WE_190_0000_Casla Bay	32.42	0.00	0.00	13.75	0.00	0.00	0.00
WE_200_0000_Kilkieran Bay	121.13	0.00	0.00	6.81	0.00	0.00	0.00
WE_200_0200_Camus Bay	66.10	0.00	0.00	9.61	0.00	0.00	0.00
WE_250_0000_Western Atlantic Seaboard (HAs 32;33;34)	346.96	0.39	0.00	11.93	0.00	0.00	0.23
WE_260_0000_Mannin Bay	21.62	0.00	0.00	0.00	0.00	0.00	0.00
WE_260_0100_Loch an tSaile (Lough Athola), Mannin Bay	3.20	0.00	0.00	0.00	0.00	0.00	0.00
WE_270_0100_Clifden Bay	28.68	0.00	0.00	2.18	0.00	0.00	2.26
WE_290_0100_Lough Anillaun, Cleggan Bay	2.35	0.00	0.00	0.00	0.00	0.00	0.00
WE_300_0000_Ballynakill Bay	48.21	3.32	3.00	0.00	0.00	0.00	0.00
WE_310_0000_Killary Harbour	44.51	0.00	0.00	21.15	0.00	0.00	0.00
WE_310_0100_Erriff Estuary	4.72	0.00	0.00	75.91	0.00	0.00	0.00
WE_320_0100_Corragaun Lough	3.58	0.00	0.00	0.00	0.00	0.00	0.00
WE_330_0100_Roonagh Lough	3.93	0.00	0.00	0.00	0.00	0.00	0.00
WE_340_0000_Clew Bay	40.42	0.00	0.00	22.32	0.00	0.00	0.10
WE_350_0000_Inner Clew Bay	75.53	0.15	0.00	0.00	0.00	0.00	0.00
WE_350_0100_Westport Bay	49.69	0.00	0.00	2.08	0.00	0.00	0.93
WE_350_0200_Newport Bay	39.88	0.00	0.00	0.00	0.00	0.00	3.41
WE_360_0000_Blacksod Bay	152.77	2.06	0.00	9.24	0.00	0.00	1.47
WE_370_0000_Blacksod Bay SW / Achill Sound	81.95	0.00	0.00	15.66	0.00	0.00	2.13
WE_380_0000_Bellacragher Bay	39.86	0.00	0.00	12.53	0.00	0.00	0.00
WE_390_0100_Tullaghan Bay	63.36	2.35	0.00	6.25	0.00	0.00	0.00
WE_400_0000_Broadhaven	61.66	0.00	0.00	6.76	0.00	0.00	0.00
WE_400_0200_Sruwaddacon Bay	40.59	0.00	6.09	27.89	0.00	0.00	0.00
WE_405_0000_Belmullet Bay	26.66	0.00	0.00	10.05	0.00	0.00	3.46
WE_410_0100_Bunatrahir Bay	3.84	15.18	0.00	16.21	0.00	0.00	0.00
WE_420_0000_Killala Bay	43.75	4.35	0.00	0.00	0.00	0.00	2.15
WE_420_0300_Moy Estuary	31.94	0.00	0.00	0.00	0.00	0.00	13.46
WE_430_0000_Donegal Bay Southern	78.39	0.45	0.00	0.00	0.00	0.00	0.00
WE_440_0100_Easky Estuary	0.83	18.23	0.00	0.00	0.00	0.00	0.00
WE_450_0000_Sligo Bay	43.23	7.98	0.00	0.00	0.00	0.00	0.45
WE_460_0000_Ballysadare Bay	18.84	4.67	0.00	0.00	0.00	0.00	0.00
WE_470_0000_Sligo Harbour	9.87	0.00	0.00	0.00	0.00	0.00	16.79
WE_470_0100_Garavoge Estuary	18.68	7.46	0.00	0.00	0.00	0.00	37.19

6.3.4 Water bodies further characterised as at risk of failing to achieve Good Ecological Status

On completion of the application of TraC-MImAS, fourteen water bodies (of the 122 assessed) indicated that over 15% (Good – Moderate boundary) of their system capacity is used by the impacts associated with existing anthropogenic physical alterations, with Fane Estuary only just exceeding this MCL (15.1%). Appendix 6-4 contains Water Body Summary Sheets which outline, where possible, the physical and ecological characteristics of each of these water bodies as well as details of the pressures identified for each.

6.3.5 Results Summary

Appendix 6-3 tabulates the results for both the initial risk assessment and further characterisation for all 309 TraC water bodies. On reviewing these results for each water body, it is important to note where orthophotos were available for digitising pressure footprints. The availability of orthophotos is identified in this appendix as an indicator of higher level of confidence in the assessment.

Table 6.11 below summarises how morphological pressures are distributed across the RBDs by indicating the percentage coverage of each pressure type within each RBD and summing this for the whole RBD. Tables 6.12 – 6.18 detail for each RBD the pressure footprints identified, and express these as a proportion of the RBD TraC water body area. The 'percentage coverage' referred to in this section is associated with the extent of the pressure footprints and does not reflect the percentage of system capacity used (as calculated using TraC-MImAS).

The NWRBD and WRBD contain the least percentage coverage of morphological pressures footprints identified. Both of these RBDs have a higher proportion of coastal bedrock water bodies, and are more characteristic of rocky shorelines than the other RBDs which tend to be dominated by sedimentary coasts. The low percentage coverage of shoreline reinforcement within these RBDs reflects these characteristics.

Generally, with the exception of 'low impact dredging' (maintenance) and 'other disturbances to seabed', morphological pressures are most extensive within transitional water bodies. This was an expected result as many of Ireland's urban/industrial areas as well as sensitive coastlines are concentrated within the transitional water bodies.

Low impact dredging and other disturbances to seabed are significant pressures within all RBDs. Low impact dredging is of most significance within the Shannon and South Western RBDs, where this pressure is associated with the maintenance of both shipping navigation channels and drainage channels. The pressure 'other disturbances to seabed' combines the footprints of shellfish dredging, ferry channels, marine cables and pipelines, and areas zoned for wind farm development. Areas designated for shellfish dredging are the primary footprints within this pressure, with only 5% of the total footprint of 'other disturbances to seabed' associated with the other pressure types such as ferry channels, marine cables etc.

Shannon International River Basin District (ShIRBD)

The ShIRBD exhibits the most extensive shoreline and areal pressure footprints. However, the areal pressures are primarily associated with low impact dredging and other disturbances to seabed; the latter requires further assessment of aquaculture areas to confirm pressure extents. Nearly 14% of this river basin district's shoreline is embanked, which is 11% greater than any other RBD. This extensive network of embankments within the ShIRBD is heavily concentrated on the following water bodies:

- Cashen
- Fergus Estuary
- Maigue Estuary
- Upper Shannon Estuary

Eastern River Basin District (ERBD)

The ERBD is also subject to extensive shoreline pressure footprints, with nearly 13% of its entire shoreline reinforced. Also, approximately 38% of the ERBD TraC water body area is subject to pressures such as low impact dredging (maintenance dredging), land claim and other disturbances to seabed. The latter pressure consists of footprints for shellfish dredging, vessel movements, and marine cables and pipelines; shellfish dredging was identified as the most significant of the three. Over 1% of this RBD's coast has been reclaimed, a significant proportion of which is in the Dublin area.

Neagh-Bann River Basin District (NBRBD)

The most significant pressures footprints identified for the NBRBD TraC water bodies are those associated with other disturbances to seabed, low impact dredging and embankments. Of those embankments identified all features were concentrated within the Glyde Estuary (7.7km). However, as noted in section 6.3.3 (iii) above, approximately 12.7 km of embankments were also identified for Ballymascanlan Estuary.

South Western River Basin District (SWRBD)

A significant proportion of the SWRBD's TraC water body area has been identified as impacted by shellfish dredging, which is a component of the pressure 'other disturbances to seabed'. Second only to the ShIRBD, over 6% of this RBD's total water body area is subject to low impact dredging. The majority of the high impact shoreline reinforcement identified is concentrated on the transitional water bodies.

South Eastern River Basin District (SERBD)

Second only to the ERBD, a significant portion of the SERBD's shoreline is subject to high impact shoreline reinforcement. The other significant pressures identified for this RBD are low impact dredging and other disturbances to seabed. The latter pressure type is associated with ferry movements, marine cables and pipelines, as well as shellfish dredging areas (which still require confirmation of extents).

Western River Basin District (WRBD)

The most significant pressure on the WRBD TraC water bodies is that associated with shellfish dredging, with over 25% of its area designated as the pressure 'other disturbances to seabed'. Low impact dredging also contributes to the morphological pressures within this district, whereas footprints for all other pressures are minimal.

North Western River Basin District (NWRBD)

Limited pressure footprints were identified for this RBD as a whole, with the most extensive pressures of low impact dredging and 'other disturbances to seabed' present in approximately 5% and 10% of the TraC water body area respectively. Although the results indicate that pressure footprints are limited for the RBD overall, the concentration of embankments within the following water bodies has significant impact on their potential to achieve GES:

- Blanket Nook Lough
- Foyle and Faughan Estuaries
- Inch Lough
- Swilly Estuary

Table 6.11: Distribution of pressure footprints across each River Basin District, expressed as total area/length and percentage coverage

			Areal Pressure Footprints (km2)								Linear Pressure Footprints (km)			
	Total Water Body Area & % Pressure Coverage per RBD	Total Water Body Perimeter & % Pressure Coverage per RBD	Land Claim - High Impact	Land Claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
ERBD														
Total Area (km^2) & Length (km)	383.06	639.12	4.262	0.523	0	10.953	129.971	2.715	0.283	0.020	45.448	33.854	4.033	0
Proportion (%) of total Water Body with Pressure Footprints	38.83	13.04	1.11	0.14	0	2.86	33.93	0.71	0.07	0.01	7.11	5.30	0.63	0
NBRBD														
Total Area (km^2) & Length (km)	310.99	343.27	0	0	0	8.924	84.136	1.142	0.002	0.000	3.093	0.197	7.730	0
Proportion (%) of total Water Body with Pressure Footprints	30.29	3.21	0	0	0	2.87	27.05	0.37	0.00	0.00	0.90	0.06	2.25	0
NWRBD														
Total Area (km^2) & Length (km)	2361.42	2215.81	0.249	0.151	0	119.143	232.489	0.845	0.162	0.017	16.627	3.772	58.089	1.985
Proportion (%) of total Water Body with Pressure Footprints	14.95	3.63	0.01	0.01	0	5.05	9.85	0.04	0.01	0.00	0.75	0.17	2.62	0.09
SERBD														
Total Area (km^2) & Length (km)	1114.27	1107.59	1.042	0.014	0.661	57.827	158.587	1.409	0.108	0.010	28.592	9.371	16.748	0.571
Proportion (%) of total Water Body with Pressure Footprints	19.71	4.99	0.09	0.00	0.06	5.19	14.23	0.13	0.01	0.00	2.58	0.85	1.51	0.05
ShIRBD														
Total Area (km^2) & Length (km)	1470.23	1529.91	3.139	0.049	0.077	178.131	419.030	2.832	0.092	0.039	21.446	1.345	213.792	0
Proportion (%) of total Water Body with Pressure Footprints	41.04	15.46	0.21	0.00	0.01	12.12	28.50	0.19	0.01	0.00	1.40	0.09	13.97	0
SWRBD														
Total Area (km^2) & Length (km)	3241.63	3091.91	2.538	0.491	0.047	203.758	436.681	7.487	0.313	0.112	77.545	14.144	76.620	1.779
Proportion (%) of total Water Body with Pressure Footprints	20.10	5.50	0.08	0.02	0.00	6.29	13.47	0.23	0.01	0.00	2.51	0.46	2.48	0.06
WRBD														
Total Area (km^2) & Length (km)	4707.56	3944.52	0.252	0.010	0	200.984	1189.881	0.637	0.166	0.011	18.080	1.2230	0	2.688
Proportion (%) of total Water Body with Pressure Footprints	29.57	0.56	0.01	0.00	0	4.27	25.28	0.01	0.00	0.00	0.46	0.03	0	0.07

Table 6.12: Summary of pressure footprints identified for TraC water bodies within the ERBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km^2)	Perimeter (km^2)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
EA_010_0000	Boyne Estuary Plume Zone	CW5	4.5551	9.7400	0	0	0	0.0018	1.9999	0.2016	0	0	0	0	0	0
EA_090_0000	Dublin Bay	CW5	48.0508	63.4550	1.2971	0.0381	0	5.5014	8.5465	0	0.1104	0.0016	2.821	6.750	0	0
EA_070_0000	Irish Sea Dublin (HA 09)	CW5	43.4760	59.1960	0.1115	0.0680	0	0.0026	13.6521	0	0.0627	0	0.303	0.547	0	0
EA_060_0000	Malahide Bay	CW8	2.3371	10.9400	0.0650	0	0	0	0	0	0.0239	0.0033	0.052	0	0	0
EA_020_0000	Northwestern Irish Sea (HA 08)	CW5	115.0393	121.0510	0	0	0	0.0031	84.9859	1.2580	0.0102	0.0002	3.080	2.256	0	0
EA_040_0000	Rockabill	CW5	11.8275	12.8170	0	0	0	0	0	0	0	0	0	0	0	0
EA_140_0000	Southwestern Irish Sea - Brittas Bay (HA 10)	CW6	46.9472	54.9240	0	0.1165	0	0	1.7275	0.7508	0.0158	0.0018	0.993	3.150	0	0
EA_100_0000	Southwestern Irish Sea - Killiney Bay (HA10)	CW5	87.2831	102.4150	0.1139	0	0	0.7432	16.1005	0.5047	0.0054	0	1.568	6.980	0	0
Total area / length of coastal water bodies and pressure footprints			***359.52***	***434.54***	***1.59***	***0.22***	***0.00***	***6.25***	***127.01***	***2.72***	***0.23***	***0.01***	***8.82***	***19.68***	***0.00***	***0.00***
Coverage of pressure footprints per coastal water body area / length (%)					***0.442***	***0.062***	***0.000***	***1.739***	***35.329***	***0.755***	***0.064***	***0.002***	***2.029***	***4.530***	***0.000***	***0.000***
EA_150_0100	Avoca Estuary	TW2	0.1745	5.6900	0.2093	0.0315	0	0	0	0	0.0049	0.0026	1.635	1.314	0	0
EA_010_0100	Boyne Estuary	TW2	3.1636	48.9430	0.2385	0.1894	0	1.3839	0.1694	0	0.0091	0.0040	7.183	11.370	2.307	0
EA_130_0100	Broad Lough	TW2	0.8009	14.7880	0.0689	0.0037	0	0	0	0	0.0042	0.0009	0.898	0	0	0
EA_060_0100	Broadmeadow Water	TW6	3.3345	11.7810	0	0	0	0.0050	0	0	0.0002	0	3.697	0.277	0	0
EA_110_0100	Dargle Estuary	TW2	0.0313	0.7870	0	0	0	0	0	0	0.0063	0.0007	0	0	0	0
EA_120_0100	Kilcoole Marsh	TW6	0.2341	20.7410	0	0	0	0	0	0	0	0.0003	0	0	0	0
EA_090_0300	Liffey Estuary Lower	TW2	4.8046	25.7510	0	0	0	3.0201	2.7579	0	0.0235	0.0002	15.379	0	0	0
EA_090_0400	Liffey Estuary Upper	TW2	0.1952	9.1580	0	0	0	0.1861	0	0	0	0	0	0	0	0
EA_080_0100	Mayne Estuary	TW2	1.8393	9.6250	0	0.0127	0	0	0.0311	0	0.0001	0.0002	1.188	0.514	0	0
EA_030_0100	Nanny Estuary	TW2	0.2149	10.8570	0	0	0	0	0	0	0	0.0007	0	0.522	0	0
EA_090_0100	North Bull Island	TW6	2.1259	8.6680	0.0049	0.0420	0	0.1056	0	0	0.0002	0	3.196	0	0	0
EA_050_0100	Rogerstown Estuary	TW2	3.0464	19.5370	0.3542	0.0207	0	0	0	0	0.0041	0.0006	0.538	0.174	0	0
EA_090_0200	Tolka Estuary	TW2	3.5782	18.2510	1.7991	0	0	0	0	0	0.0025	0.0029	2.917	0	1.726	0
Total area / length of coastal water bodies and pressure footprints			***23.54***	***204.58***	***2.67***	***0.30***	***0.00***	***4.70***	***2.96***	***0.00***	***0.06***	***0.01***	***36.63***	***14.17***	***4.03***	***0.00***
Coverage of pressure footprints per coastal water body area / length (%)					***11.361***	***1.274***	***0.000***	***19.966***	***12.566***	***0.000***	***0.234***	***0.057***	***17.906***	***6.927***	***1.971***	***0.000***
Total RBD area / length			***383.06***	***639.12***	***4.262***	***0.523***	***0.000***	***10.953***	***129.971***	***2.715***	***0.283***	***0.020***	***45.448***	***33.854***	***4.033***	***0.000***
Coverage of pressure footprints per RBD area / length (%)					***1.113***	***0.136***	***0.000***	***2.859***	***33.930***	***0.709***	***0.074***	***0.005***	***7.111***	***5.297***	***0.631***	***0.000***

Table 6.13: Summary of pressure footprints identified for TraC water bodies within the NBRBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km^2)	Perimeter (km^2)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
NB_030_0000	Carlingford Lough	CW8	44.6729	49.0920	0	0	0	3.2074	8.1308	0	0	0	0.779	0	0	0
NB_025_0000	Louth Coast (HA 06)	CW5	38.4497	43.6120	0	0	0	0	18.6110	1.1423	0.0015	0	0.757	0.047	0	0
NB_040_0000	Outer Dundalk Bay	CW5	63.7207	60.7050	0	0	0	0.4346	35.6075	0	0	0	1.344	0	0	0
NB_010_0000	Portstewart Bay	CW2	122.4223	55.7890	0	0	0	2.9833	0	0	0.0002	0	0.113	0.150	0	0
Total area / length of coastal water bodies and pressure footprints			***269.27***	***209.20***	***0.00***	***0.00***	***0.00***	***6.63***	***62.35***	***1.14***	***0.00***	***0.00***	***2.99***	***0.20***	***0.00***	***0.00***
Coverage of pressure footprints per coastal water body area / length (%)					***0.000***	***0.000***	***0.000***	***2.461***	***23.155***	***0.424***	***0.001***	***0.000***	***1.431***	***0.094***	***0.000***	***0.000***
NB_040_0300	Ballymascanlan Estuary	TW2	0.8903	12.6510	0	0	0	0	0	0	0	0	0	0	0	0
NB_010_0100	Bann Estuary	TW2	2.4981	28.2740	0	0	0	0	0	0	0	0	0	0.000	0	0
NB_030_0200	Carlingford Lagoons	TW6	0.0160	1.8550	0	0	0	0	0	0	0	0	0	0	0	0
NB_040_0200	Castletown Estuary	TW2	1.8761	15.4250	0	0	0	0	0	0	0	0	0	0	0	0
NB_040_0600	Corstown Lagoon	TW6	0.0012	0.1320	0	0	0	0	0	0	0	0	0	0	0	0
NB_040_0400	Fane Estuary	TW2	0.0934	8.4470	0	0	0	0.0750	0	0	0	0	0	0	0	0
NB_040_0500	Glyde Estuary	TW2	0.1186	9.3960	0	0	0	0.1186	0	0	0	0	0	0	7.730	0
NB_040_0100	Inner Dundalk Bay	TW2	33.3460	31.8740	0	0	0	1.8661	21.7862	0	0	0	0.100	0	0	0
NB_030_0100	Newry Estuary	TW2	2.8778	25.7150	0	0	0	0.2392	0	0	0	0	0	0	0	0
NB_030_0250	Shilties Lough	TW6	0.0031	0.3010	0	0	0	0	0	0	0	0	0	0	0	0
Total area / length of coastal water bodies and pressure footprints			***41.72***	***134.07***	***0.00***	***0.00***	***0.00***	***2.30***	***21.79***	***0.00***	***0.00***	***0.00***	***0.10***	***0.00***	***7.73***	***0.00***
Coverage of pressure footprints per coastal water body area / length (%)					***0.000***	***0.000***	***0.000***	***5.510***	***52.219***	***0.000***	***0.000***	***0.000***	***0.075***	***0.000***	***5.766***	***0.000***
Total RBD area / length			***310.99***	***343.27***	***0.000***	***0.000***	***0.000***	***8.924***	***84.136***	***1.142***	***0.002***	***0.000***	***3.093***	***0.197***	***7.730***	***0.000***
Coverage of pressure footprints per RBD area / length (%)					***0.000***	***0.000***	***0.000***	***2.870***	***27.054***	***0.367***	***0.001***	***0.000***	***0.901***	***0.057***	***2.252***	***0.000***

Table 6.14: Summary of pressure footprints identified for TraC water bodies within the NWRBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km²)	Perimeter (km²)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
NW_170_0000	Ballyness Bay	CW5	5.9485	27.3120	0	0	0	0	0	0	0.0014	0.000	0	0	0	0
NW_020_0000	Bundoran Bay	CW5	1.9209	10.7320	0	0	0	0	0	0	0.0015	0	0	0	0	0
NW_010_0000	Donegal Bay (Erne)	CW5	226.0561	85.7420	0	0	0	0.0118	15.1235	0	0.0053	0	0	0	0	0
NW_070_0000	Donegal Bay Northern	CW2	518.2858	133.8440	0	0	0	81.0819	4.2690	0.4355	0.0020	0	0.090	0	0	0
NW_140_0000	Dungloe Bay	CW5	11.7112	58.3990	0	0	0	0	0	0.041165	0.0025	0	0.266	0	0	0
NW_120_0000	Gweebarra Bay	CW5	34.6608	32.1430	0	0	0	0	7.5664	0	0.0009	0	0	0.121	0	0
NW_160_0000	Gweedore Bay	CW5	32.8801	93.8330	0	0	0	0	0	0	0.0041	0	0	0	0	0
NW_060_0000	Inver Bay	CW5	13.3790	17.5580	0	0	0	0	6.8086	0	0.0015	0	0	0	0	0
NW_085_0000	Killybegs Harbour	CW8	2.8339	16.9780	0	0	0	0.9414	0	0	0.0441	0.013	0	0	0	0
NW_250_0000	Lough Foyle	CW8	165.7285	61.7800	0	0	0	8.2741	0	0	0.0189	0	1.662	1.389	0	0
NW_220_0000	Lough Swilly	CW5	97.7463	91.9130	0	0	0	12.8065	23.3281	0	0.0047	0.002	1.842	0	0	0
NW_110_0000	Loughros Bay	CW5	30.9434	66.4530	0	0	0	0	4.7062	0	0.0010	0	0.287	0	0	0
NW_080_0000	McSwines Bay	CW5	16.3170	26.3510	0	0	0	0.6941	0	0	0.0007	0	0	0	0	0
NW_200_0000	Mulroy Bay Broadwater	CW8	30.4289	106.2790	0	0	0	0	0	0	0.0035	0.000	0	0	0	0
NW_210_0000	Mulroy Bay Northwater	CW8	4.5968	27.7790	0	0	0	0	0	0	0.0002	0	0	0	0	0
NW_230_0000	Northern Atlantic Seaboard (HAs 40;02)	CW2	200.0678	177.1150	0	0	0	2.9609	89.0847	0	0.0040	0	0.115	0	0	0
NW_100_0000	Northwestern Atlantic Seaboard (HAs 37;38)	CW2	735.5116	460.8540	0	0.1511	0	10.6930	8.1467	0.0718	0.0061	0	0	0.159	0	0
NW_150_0000	Rutland Sound	CW5	9.4564	61.5700	0	0	0	0	0	0	0.0099	0	0.242	0	0	0
NW_150_0100	Sally's Lough	CW10	0.0452	1.7510	0	0	0	0	0	0	0	0	0	0	0	0
NW_190_0000	Sheephaven Bay	CW5	38.1668	77.2580	0.0056	0	0	0	0	0	0.0057	0	0.198	0	0	0
NW_180_0000	Tory Island Waters	CW2	32.8296	45.4120	0	0	0	0	0	0.2968	0.0027	0	0	0	0	0
NW_240_0000	Trawbreaga Bay	CW8	12.0989	39.3860	0	0	0	0	12.0039	0	0.0000	0	0	0	0	0
NW_130_0000	Trawena Bay	CW8	8.4127	25.8700	0	0	0	0	0	0	0	0	0	0	0	0
Total area / length of coastal water bodies and pressure footprints			***2230.03***	***1746.31***	***0.01***	***0.15***	***0.00***	***117.46***	***171.04***	***0.85***	***0.12***	***0.02***	***4.70***	***1.67***	***0.00***	***0.00***
Coverage of pressure footprints per coastal water body area / length (%)					***0.000***	***0.007***	***0.000***	***5.267***	***7.670***	***0.038***	***0.005***	***0.001***	***0.269***	***0.096***	***0.000***	***0.000***
NW_220_0200	Blanket Nook Lough	TW6	0.3203	4.6780	0	0	0	0.0400	0	0	0	0	0	0	11.855	0
NW_200_0200	Carrick Beg Lough (South)	TW6	0.0139	0.5340	0	0	0	0	0	0	0	0	0	0	0	0
NW_220_0400	Crana Estuary	TW2	0.8343	7.1880	0	0	0	0	0	0	0.0074	0.0003	0	0.560	0	0
NW_020_0100	Drowes Estuary	TW2	0.1372	1.8290	0	0	0	0	0	0	0	0	0	0	0	0
NW_010_0100	Duff Estuary	TW2	0.0053	0.4600	0	0	0	0.0053	0	0	0	0	0	0	0	0
NW_040_0100	Durnesh Lough	TW6	0.6964	8.1990	0	0	0	0	0	0	0	0	0	0	0	0
NW_060_0100	Eany Water Estuary	TW2	0.0771	3.9360	0	0	0	0	0	0	0.0002	0	0	0	0	0
NW_030_0100	Erne Estuary	TW2	2.5743	12.3110	0	0	0	0	0	0	0.0009	0.0003	0	0	0	0
NW_250_0100	Foyle and Faughan Estuaries	TW2	34.4844	124.6530	0.2432	0	0	1.5449	0	0	0.0002	0	0	0	11.580	0
NW_120_0100	Gweebarra Estuary	TW2	8.2565	46.0440	0	0	0	0	2.7872	0	0.0001	0	0.430	0	0	0
NW_160_0200	Gweedore Estuary	TW2	4.4500	35.5630	0	0	0	0	0	0	0.0003	0	0	0	0	0
NW_220_0300	Inch Lough	TW6	1.6287	10.5580	0	0	0	0.0027	0	0	0	0	0	0	11.516	0
NW_050_0100	Inner Donegal Bay	TW2	8.1223	48.5860	0	0	0	0	0	0	0.0057	0.0003	1.997	0	0	0
NW_190_0100	Lackagh Estuary	TW2	1.2162	10.9010	0	0	0	0	0	0	0	0	0	0	0	0
NW_160_0100	Loch Chionn Caslach (Kincas Lough)	TW6	0.0425	1.3080	0	0	0	0	0	0	0	0	0	0	0	0
NW_180_0100	Loch O Dheas, Tory Island	TW6	0.0352	1.1350	0	0	0	0	0	0	0	0	0	0	0	0
NW_140_0100	Maghery Lough	TW6	0.1670	2.3340	0	0	0	0	0	0	0	0	0	0	0	0
NW_160_0500	Meenaclady	TW2	0.0547	2.7090	0	0	0	0	0	0	0.0057	0	0	0	0	0
NW_160_0300	Moorlagh	TW6	0.0777	1.5560	0	0	0	0	0	0	0	0	0	0	0	0
NW_110_0100	Owenea Estuary	TW2	7.7138	31.4670	0	0	0	0	0.1703	0	0.0002	0	0	0	0	0
NW_220_0100	Swilly Estuary	TW2	59.3555	103.7890	0	0	0	0.0859	58.4947	0	0.0187	0.0006	9.420	1.543	23.139	1.985
NW_090_0100	Teelin Bay	TW2	1.1323	9.7560	0	0	0	0	0	0	0.0017	0	0.078	0	0	0
Total area / length of coastal water bodies and pressure footprints			***131.40***	***469.49***	***0.24***	***0.00***	***0.00***	***1.68***	***61.45***	***0.00***	***0.04***	***0.00***	***11.93***	***2.10***	***58.09***	***1.99***
Coverage of pressure footprints per coastal water body area / length (%)					***0.185***	***0.000***	***0.000***	***1.278***	***46.769***	***0.000***	***0.031***	***0.001***	***2.540***	***0.448***	***12.373***	***0.423***
Total RBD area / length			***2361.42***	***2215.81***	***0.249***	***0.151***	***0.000***	***119.143***	***232.489***	***0.845***	***0.162***	***0.017***	***16.627***	***3.772***	***58.089***	***1.985***
Coverage of pressure footprints per RBD area / length (%)					***0.011***	***0.006***	***0.000***	***5.045***	***9.845***	***0.036***	***0.007***	***0.001***	***0.750***	***0.170***	***2.622***	***0.090***

Table 6.15: Summary of pressure footprints identified for TraC water bodies within the SERBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km^2)	Perimeter (km^2)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
SE_090_0000	Bannow Bay	CW8	9.5402	28.5340	0	0	0	0	0	0	0	0	1.695	0	0	0
SE_140_0000	Dungarvan Harbour	CW5	22.8231	25.1140	0	0	0	0	1.9826	0	0	0	2.616	0.880	0	0
SE_050_0000	Eastern Celtic Sea (HAs 13;17)	CW2	797.2917	295.1390	0	0	0	17.3949	143.5533	1.2372	0.0023	0	4.855	1.110	0	0
SE_045_0000	Rosslare Harbour	CW5	0.1073	1.8430	0	0	0	0.1060	0	0	0	0	0	0	0	0
SE_010_0000	Southwestern Irish Sea (HAs 11;12)	CW5	123.5815	139.8560	0	0	0	15.9996	7.9104	0.1523	0.0138	0	3.702	3.020	0	0
SE_120_0000	Tramore Back Strand	CW8	5.3019	21.3790	0.7397	0	0	0	1.8063	0	0.0340	0	1.204	0.592	2.453	0
SE_110_0000	Tramore Bay	CW5	12.2499	16.9160	0	0	0	0	0	0	0.0007	0	1.490	0	0	0
SE_100_0000	Waterford Harbour	CW2	33.3757	32.2250	0	0	0	13.6966	0.5425	0	0.0240	0.0040	0.315	0.706	0	0
SE_040_0000	Wexford Harbour	CW8	19.8100	27.1730	0	0	0	0	0	0	0.0048	0	0.409	0.582	4.063	0
Total area / length of coastal water bodies and pressure footprints			***1024.08***	***588.18***	***0.74***	***0.00***	***0.00***	***47.20***	***155.80***	***1.39***	***0.08***	***0.00***	***16.29***	***6.89***	***6.52***	***0.00***
Coverage of pressure footprints per coastal water body area / length (%)					***0.072***	***0.000***	***0.000***	***4.609***	***15.213***	***0.136***	***0.008***	***0.000***	***2.769***	***1.171***	***1.108***	***0.000***
SE_080_0200	Ballyteige Channels	TW6	0.4657	10.5800	0	0	0	0.4444	0	0	0	0	0	0	0	0
SE_100_0250	Barrow Nore Estuary Upper	TW2	0.6429	9.1480	0	0	0	0	0	0	0	0	0	0	0	0
SE_100_0100	Barrow Suir Nore Estuary	TW2	28.2138	44.0760	0	0	0.5105	6	2.7923	0.0199	0	0	1.620	0.874	0.000	0
SE_140_0200	Brickey Estuary	TW2	0.6285	9.1090	0	0	0	0.0544	0	0	0	0	0	0	2.836	0
SE_080_0100	Bridgetown Estuary	TW2	2.0283	18.2380	0	0	0	0.2419	0	0	0	0	0.832	0.000	4.711	0.000
SE_140_0100	Colligan Estuary	TW2	10.0265	34.1220	0	0	0	0	0	0	0	0	5.490	0.000	0	0
SE_090_0100	Corock Estuary	TW2	0.3487	11.1060	0	0	0	0	0	0	0	0	0	0	0	0
SE_060_0100	Lady's Island Lake	TW6	2.9605	17.7190	0	0	0	0	0	0	0	0	0	0	0	0
SE_040_0200	Lower Slaney Estuary	TW2	18.3502	63.3750	0.3024	0.0143	0	0	0	0	0.0287	0.0052	0.684	1.607	2.211	0.571
SE_100_0500	Lower Suir Estuary	TW2	4.3235	30.8060	0	0	0.1501	1.4039	0	0	0	0	0	0	0	0
SE_130_0100	Mahon Estuary	TW2	0.0956	8.2330	0	0	0	0	0	0	0	0	0	0	0	0
SE_100_0550	Middle Suir Estuary	TW2	7.0323	65.3870	0	0	0	0.4422	0	0	0	0	0	0	0	0
SE_100_0200	New Ross Port	TW2	6.7110	40.2100	0	0	0	1.8972	0	0	0	0	0	0	0	0
SE_100_0400	Nore Estuary	TW2	1.2578	34.1180	0	0	0	0	0	0	0	0	0	0	0	0
SE_040_0100	North Slob Channels	TW6	0.3718	11.2190	0	0	0	0	0	0	0	0	0	0	0	0
SE_020_0100	Owenavorragh Estuary	TW2	0.0631	4.4100	0	0	0	0.0281	0	0	0	0	2.626	0	0	0
SE_040_0400	South Slob Channel	TW6	0.5206	5.5770	0	0	0	0	0	0	0	0	0	0	0	0
SE_070_0100	Tacumshin Lake	TW6	3.1053	21.6510	0	0	0	0	0	0	0	0	0	0	0	0
SE_100_0300	Upper Barrow Estuary	TW2	1.1472	34.0110	0	0	0	0	0	0	0	0	0	0	0	0
SE_040_0300	Upper Slaney Estuary	TW2	0.8069	18.0740	0	0	0	0	0	0	0	0	0	0	0	0
SE_100_0600	Upper Suir Estuary	TW2	1.0902	28.2420	0	0	0	0.1066	0	0	0	0.0006	1.054	0.000	0.474	0
Total area / length of coastal water bodies and pressure footprints			***90.19***	***519.41***	***0.30***	***0.01***	***0.66***	***10.63***	***2.79***	***0.02***	***0.03***	***0.01***	***12.31***	***2.48***	***10.23***	***0.57***
Coverage of pressure footprints per coastal water body area / length (%)					***0.335***	***0.016***	***0.733***	***11.786***	***3.096***	***0.022***	***0.032***	***0.007***	***2.369***	***0.478***	***1.970***	***0.110***
Total RBD area / length			***1114.27***	***1107.59***	***1.042***	***0.014***	***0.661***	***57.827***	***158.587***	***1.409***	***0.108***	***0.010***	***28.592***	***9.371***	***16.748***	***0.571***
Coverage of pressure footprints per RBD area / length (%)					***0.094***	***0.001***	***0.059***	***5.190***	***14.232***	***0.126***	***0.010***	***0.001***	***2.581***	***0.846***	***1.512***	***0.052***

Table 6.16: Summary of pressure footprints identified for TraC water bodies within the ShIRBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km^2)	Perimeter (km^2)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
SH_030_0000	Brandon Bay	CW5	47.02	38.63	0	0	0	0	47.013	0	0	0	0.564	0.452	0	0
SH_060_1400	Clooncondeen Pool	CW10	0.05	1.12	0	0	0	0	0	0	0	0	0	0	0	0
SH_080_0000	Doonbeg Bay	CW5	6.34	11.92	0	0	0	0.030	0	0	0	0	0.225	0	0	0
SH_050_0000	Inner Tralee Bay	CW8	15.61	28.11	0	0	0.006	0.498	15.607	0	0.022	0	1.881	0.194	0	0
SH_100_0000	Liscannor Bay	CW2	30.31	28.27	0	0	0	0	0	0	0.001	0	2.010	0	0	0
SH_060_0000	Mouth of the Shannon (HAs 23;27)	CW2	334.13	186.62	0.031	0.010	0	81.468	51.352	0	0.015	0.001	5.364	0.035	6.551	0
SH_040_0000	Outer Tralee Bay	CW5	215.81	111.56	0	0	0	31.181	215.096	1.577	0.0002	0.002	2.501	0.136	0	0
SH_060_1300	Scattery Island Lagoon	CW10	0.02	0.63	0	0	0	0	0	0	0	0	0	0	0	0
SH_070_0000	Shannon Plume (HAs 27;28)	CW2	379.35	249.78	0	0	0	6.923	67.273	0	0.003	0.0002	2.892	0	0.100	0
SH_020_0000	Smerwick Harbour	CW5	12.58	29.50	0	0	0	0	0	0	0.001	0	0.074	0.069	0	0
SH_010_0000	Southwestern Atlantic Seaboard (HA 23)	CW2	178.88	182.70	0	0	0	12.158	19.626	0	0	0	0.059	0	0	0
Total area / length of coastal water bodies and pressure footprints			*1220.10*	*868.83*	*0.03*	*0.01*	*0.01*	*132.26*	*415.97*	*1.58*	*0.04*	*0.004*	*15.57*	*0.89*	*6.65*	*0.00*
Coverage of pressure footprints per coastal water body area / length (%)					*0.003*	*0.001*	*0.001*	*10.840*	*34.093*	*0.129*	*0.003*	*0.0003*	*1.792*	*0.102*	*0.765*	*0.00*
SH_110_0100	Aille Clare Estuary	TW2	0.10	1.56	0	0	0	0	0	0	0	0	0	0	0	0
SH_050_0200	Blennerville Lake East	TW6	0.01	0.70	0	0	0	0	0	0	0	0	0	0	0	0
SH_050_0300	Blennerville Lake West	TW6	0.01	0.48	0	0	0	0	0	0	0	0	0	0	0	0
SH_060_0100	Cashen	TW2	2.67	33.54	0	0	0	1.145	0	0	0	0.001	1.001	0.161	23.139	0
SH_060_1200	Clonderalaw Bay	TW2	3.81	21.43	0	0	0	0	0	0	0	0	0	0	7.576	0
SH_060_0600	Deel Estuary	TW2	3.02	22.23	0	0	0	0.001	0	0	0	0	0	0	1.607	0
SH_080_0100	Doonbeg Estuary	TW2	0.89	4.82	0	0	0	0	0	0	0.001	0	0	0	0	0
SH_060_1100	Fergus Estuary	TW2	64.75	171.47	1.963	0.026	0	0.020	0	0	0.002	0.0002	0	0	61.988	0
SH_060_0350	Foynes Harbour	TW2	0.75	6.10	0	0	0	0.334	0	0	0	0	0.299	0	0	0
SH_100_0100	Inagh Estuary	TW2	0.63	23.44	0	0	0	0	0	0	0	0.001	0	0	0	0
SH_050_0100	Lee K Estuary	TW2	3.06	17.11	0	0	0	0	3.063	0	0.006	0	1.703	0	0	0
SH_060_0900	Limerick Dock	TW2	2.49	40.55	0.268	0	0.058	0.107	0	0.080	0	0	0	0	7.956	0
SH_090_0100	Lough Donnell	TW6	0.15	2.13	0	0	0	0	0	0	0	0	0	0	0	0
SH_040_0100	Lough Gill	TW6	1.40	6.56	0	0	0	0.0004	0	0	0	0	0	0	0	0
SH_060_0300	Lower Shannon Estuary	TW2	123.08	162.72	0.312	0	0.013	39.698	0	1.131	0.028	0.029	2.659	0.298	7.274	0
SH_060_0700	Maigue Estuary	TW2	3.21	47.10	0	0	0	1.426	0	0	0	0	0	0	40.431	0
SH_060_0400	Poulaweala Lough / Quayfield Lough	TW6	0.01	0.98	0	0	0	0	0	0	0	0	0	0	0	0
SH_060_1000	Shannon Airport Lagoon	TW6	0.19	1.82	0	0	0	0	0	0	0	0	0	0	0	0
SH_060_0200	Upper Feale Estuary	TW2	0.38	14.30	0	0	0	0.341	0	0	0	0.0003	0	0	12.380	0
SH_060_0800	Upper Shannon Estuary	TW2	39.51	82.05	0.566	0.014	0	2.799	0	0.044	0.013	0.005	0.214	0	44.790	0
Total area / length of coastal water bodies and pressure footprints			*250.13*	*661.07*	*3.11*	*0.04*	*0.07*	*45.87*	*3.06*	*1.25*	*0.05*	*0.04*	*5.88*	*0.46*	*207.14*	*0.00*
Coverage of pressure footprints per coastal water body area / length (%)					*1.243*	*0.016*	*0.028*	*18.339*	*1.225*	*0.501*	*0.020*	*0.014*	*0.889*	*0.069*	*31.334*	*0.000*
Total RBD area / length			*1470.23*	*1529.91*	*3.139*	*0.049*	*0.077*	*178.131*	*419.030*	*2.832*	*0.092*	*0.039*	*21.446*	*1.345*	*213.792*	*0.000*
Coverage of pressure footprints per RBD area / length (%)					*0.214*	*0.003*	*0.005*	*12.116*	*28.501*	*0.193*	*0.006*	*0.003*	*1.402*	*0.088*	*13.974*	*0.00*

Table 6.17: Summary of pressure footprints identified for TraC water bodies within the SWRBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km^2)	Perimeter (km^2)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
SW_200_0000	Ballinskelligs Bay	CW2	48.9436	60.2050	0	0	0	0	0	0	0.0004	0	1.610	0	0.492	0
SW_040_0000	Ballycotton Bay	CW5	26.5841	33.2120	0	0	0	0	0	0	0.0034	0	1.708	0.619	0	0
SW_140_0100	Ballyrisode Bridge Lagoon	CW10	0.0113	0.4420	0	0	0	0	0	0	0	0	0	0	0	0
SW_180_0000	Berehaven	CW5	16.3341	54.8770	0.0437	0.0024	0	16.2255	7.7652	0	0.0112	0.0027	1.552	1.095	0	0
SW_100_0400	Clogheen Strand	CW10	0.1292	3.1410	0	0	0	0.0046	0	0	0	0	0	0	0	0
SW_100_0000	Clonakilty Bay	CW5	31.7952	43.8780	0	0	0	0	0	0	0.0014	0	0.944	0	0	0
SW_060_0000	Cork Harbour	CW8	27.8111	55.1410	0.9124	0.2836	0.0469	4.5777	11.5303	0	0.0296	0.0298	11.947	1.135	0.385	0.787
SW_090_0000	Courtmacsherry Bay	CW5	59.0482	52.9850	0	0	0	0	0.1973	0	0.0006	0.0025	1.510	0	0	0
SW_240_0000	Dingle Harbour	CW5	4.1880	15.8100	0.0413	0	0	0	0	0.4864	0.0276	0.0002	1.364	1.967	0.685	0
SW_160_0000	Dunmanus Bay	CW2	84.5382	113.0170	0.0014	0	0	0	14.5749	0	0.0047	0.0001	0.196	0.810	0.144	0
SW_120_0000	Fastnet Waters	CW2	10.9455	12.0350	0	0	0	0	0	0	0	0	0	0	0	0
SW_100_0200	Inchydoney	CW10	0.0304	0.7450	0	0	0	0	0	0	0	0	0	0	0	0
SW_080_0000	Kinsale Harbour	CW5	14.8101	29.4700	0	0	0	0	0	0	0.0005	0	0.000	0	0	0
SW_080_0200	Kinsale Marsh, Commoge	CW10	0.0495	0.9190	0	0	0	0	0	0	0	0	0	0	0	0
SW_170_0000	Outer Bantry Bay	CW2	276.1832	182.7030	0	0	0	139.9455	79.4077	0.0434	0.0058	0.0026	0.697	0	0	0
SW_050_0000	Outer Cork Harbour	CW5	31.3534	42.5710	0	0.1506	0	6.3449	0.1871	0	0.0014	0.0001	0.755	0.316	0	0.258
SW_230_0000	Outer Dingle Bay	CW2	383.1596	153.8540	0	0	0	0	3.0496	0	0.0027	0	0.996	0	0	0
SW_190_0000	Outer Kenmare River	CW2	188.7632	283.7560	0	0	0	0	188.7380	0	0.0064	0.0002	1.778	0.709	0	0
SW_210_0000	Portmagee Channel	CW8	12.5931	47.3590	0.0053	0	0	0	10.7217	0	0.0109	0.0033	0.423	0	0	0
SW_060_1000	Raffeen Lake, Shanbally	CW10	0.0284	0.7340	0	0	0	0	0	0	0	0	0	0	0	0
SW_140_0000	Roaring Water Bay	CW2	189.5933	298.7900	0	0.0002	0	0	15.6977	0.8726	0.0115	0.0024	0.392	0.060	0	0
SW_110_0000	Rosscarbery Bay	CW5	68.8294	100.7880	0.0033	0	0	0	0	5.2997	0.0032	0.0003	1.915	0	0	0
SW_150_0000	South Western Atlantic Seaboard (HAs 21;22)	CW2	1540.3034	492.5820	0	0	0	34.3488	84.8635	0.7854	0.0014	0	0.213	0.584	0	0
SW_220_0000	Valencia Harbour	CW8	11.9634	33.9970	0	0	0	0	3.0771	0	0.0006	0	0.000	0	0	0
SW_010_0000	Western Celtic Sea (HAs 18;19;20)	CW2	513.8708	387.2080	0	0	0	5.9230	0.6738	5.7748	0.0013	0	0.556	0	0	0
SW_100_0300	White's Marsh	CW10	0.0250	1.1140	0	0	0	0.0007	0	0	0	0	0	0	1.145	0
SW_020_0000	Youghal Bay	CW5	46.8265	41.2200	0	0	0	0	0	0	0.0004	0	0.173	0.624	0	0
Total area / length of coastal water bodies and pressure footprints			***3588.71***	***2542.55***	***1.01***	***0.44***	***0.05***	***207.37***	***420.48***	***13.26***	***0.13***	***0.04***	***28.73***	***7.92***	***2.85***	***1.05***
Coverage of pressure footprints per coastal water body area / length (%)					***0.028***	***0.012***	***0.001***	***5.778***	***11.717***	***0.370***	***0.003***	***0.001***	***1.130***	***0.311***	***0.112***	***0.041***
SW_170_0500	Adrigole Harbour	TW2	1.8064	10.8390	0	0.0080	0	0	0	0	0.0012	0	0.000	0	0	0
SW_190_0100	Ardgroom	TW2	5.3877	24.0860	0	0	0	0	5.3856	0	0.0011	0	0.212	0	0	0
SW_090_0200	Argideen Estuary	TW2	4.9225	24.9350	0	0.0305	0	0	0	0	0.0046	0.0032	2.000	0	0	0
SW_190_0400	Blackwater K Estuary	TW2	0.1117	2.6690	0	0	0	0	0.1115	0	0	0	0	0	0	0
SW_230_0200	Castlemaine Harbour	TW2	6.3555	66.4730	0	0	0	0.3595	0	0	0.0006	0.0014	3.100	0.098	40.724	0
SW_100_0100	Clonakilty Harbour	TW2	1.7946	10.4780	0.0320	0	0	0	0	0	0.0020	0	5.178	0	2.014	0
SW_230_0100	Cromane	TW2	50.8741	107.4500	0	0	0	0.0183	0	0	0.0174	0.0006	3.985	1.449	8.331	0
SW_060_0200	Cuskinny Lake	TW6	0.0374	0.8070	0	0	0	0	0	0	0	0	0	0	0	0
SW_190_0500	Drongawn Lough, Sneem	TW6	0.1194	2.3590	0	0	0	0	0.1192	0	0	0	0	0	0	0
SW_160_0100	Farranamagh Lough	TW6	0.0443	1.1730	0	0	0	0	0	0	0	0	0	0	0	0
SW_220_0100	Ferta	TW2	2.4057	19.9870	0.0017	0.0092	0	0	0	0	0.0002	0.0037	0.000	0	0	0
SW_110_0300	Glandore Harbour	TW2	4.4943	22.1130	0	0	0	0	0	0	0.0019	0.0036	0.775	0	0	0
SW_060_0800	Glashaboy Estuary	TW2	0.1237	4.4710	0	0	0	0	0	0	0.0016	0.0008	0.000	0	0	0
SW_170_0400	Glengarriff Harbour	TW2	3.6638	23.4900	0.0181	0	0	0	0	0	0.0006	0.0010	0.286	0	0	0
SW_130_0100	Ilen Estuary	TW2	9.6603	89.9960	0.0145	0	0	0	0	0	0.0024	0.0067	0.479	0	0	0
SW_170_0100	Inner Bantry Bay	TW2	11.7354	35.7790	0.0098	0	0	0.1493	0	0	0.0052	0.0006	2.474	0	0	0
SW_190_0300	Inner Kenmare River	TW2	3.7869	28.4130	0	0	0	0	3.7843	0	0.0012	0.0011	0.268	0	0	0
SW_110_0100	Kilkeran Lake	TW6	0.1829	1.9090	0	0	0	0	0	0	0	0	0	0	0	0
SW_190_0200	Kilmakilloge Harbour	TW2	5.8519	37.1810	0	0	0	0	5.8487	0	0.0017	0	0.078	0	0	0
SW_170_0200	Kilmore Lake, Whiddy Island	TW6	0.0568	1.0240	0	0	0	0	0	0	0	0	0	0	0	0
SW_020_0400	Lackaroe (Glendine Estuary)	TW6	0.0414	1.2960	0	0	0	0	0	0	0	0	0	0	0	0
SW_060_0900	Lee (Cork) Estuary Lower	TW2	0.8863	10.9140	0.5797	0	0	0.4197	0	0	0.0017	0.0018	5.050	0.086	0	0
SW_060_0950	Lee (Cork) Estuary Upper	TW2	0.2524	14.2880	0	0	0	0	0	0	0	0.0141	1.789	0	0	0
SW_140_0200	Lissagriffin Lake	TW6	0.1552	1.9670	0	0	0	0	0	0	0	0.0036	0.0000	0	0	0
SW_060_1100	Lough Beg / Curraghbinny	TW6	0.0140	0.6470	0	0	0	0	0	0	0	0	0	0	0	0
SW_060_0750	Lough Mahon	TW2	12.2295	52.9500	0.6252	0	0	1.3561	0	0	0.0417	0.0046	10.962	3.269	1.390	0
SW_060_0700	Lough Mahon (Harper's Island)	TW2	2.0459	17.1080	0.2255	0	0	0	0	0	0.0148	0.0066	0.666	0	3.635	0
SW_080_0100	Lower Bandon Estuary	TW2	6.7854	49.0710	0	0.0062	0	0	0	0	0.0051	0.0062	1.416	0	0	0
SW_020_0100	Lower Blackwater M Estuary / Youghal Harbour	TW2	12.0684	95.6330	0	0	0	0.0047	0	0	0.0720	0.0041	3.879	0	3.617	0
SW_060_0300	North Channel Great Island	TW2	7.9616	37.7030	0	0	0	0	0	0	0.0002	0.0008	0.938	0.066	1.267	0
SW_060_0400	Owenacurra Estuary	TW2	1.1214	13.8710	0	0	0	0	0	0	0	0	0	0	0	0.733
SW_060_1200	Owenboy Estuary	TW2	2.4223	19.2900	0.0196	0	0	0	0	0	0.0010	0	4.980	1.257	0.117	0
SW_070_0100	Oysterhaven	TW2	3.6024	29.8160	0	0	0	0	0.8727	0	0.0111	0.0035	0.089	0	0	0
SW_070_0200	Oysterhaven Lake, Clashroe	TW6	0.0231	1.2050	0	0	0	0	0	0	0	0	0	0	0	0
SW_150_0100	Reen Point Pool	TW6	0.0075	0.3810	0	0	0	0	0	0	0	0	0	0	0	0
SW_170_0300	Reenydonagan Lough	TW6	0.2408	2.7400	0	0	0	0	0	0	0	0	0	0	0	0
SW_110_0200	Rosscarbery Harbour	TW6	0.2562	2.5270	0.0045	0.0005	0	0	0	0	0	0	0.7680	0	0	0
SW_060_0100	Rostellan Lake	TW6	0.1483	2.1250	0	0	0	0	0	0	0	0	0	0	0	0
SW_060_0600	Slatty Bridge, Fota Island	TW6	0.0169	0.6430	0	0	0	0	0	0	0	0	0	0	0	0
SW_190_0600	Sneem Harbour	TW2	0.7504	15.7290	0	0	0	0	0.7489	0	0	0	0	0	0	0
SW_080_0300	Upper Bandon Estuary	TW2	0.3505	8.5950	0	0	0	0	0	0	0	0	0	0	0	0
SW_020_0500	Upper Blackwater M Estuary	TW2	0.7032	20.2350	0	0	0	0	0	0	0	0	0	0	0	0
SW_030_0100	Womanagh Estuary	TW2	1.2922	22.1960	0	0	0	0.0029	0	0	0	0.0000	0	0	12.675	0
Total area / length of coastal water bodies and pressure footprints			***166.79***	***936.56***	***1.53***	***0.05***	***0.00***	***2.31***	***16.87***	***0.00***	***0.19***	***0.07***	***49.37***	***6.23***	***73.77***	***0.73***
Coverage of pressure footprints per coastal water body area / length (%)					***0.918***	***0.033***	***0.000***	***1.385***	***10.115***	***0.000***	***0.113***	***0.041***	***5.272***	***0.665***	***7.877***	***0.078***
Total RBD area / length			***3755.50***	***3479.12***	***2.538***	***0.491***	***0.047***	***209.681***	***437.355***	***13.262***	***0.314***	***0.112***	***78.101***	***14.144***	***76.620***	***1.779***
Coverage of pressure footprints per RBD area / length (%)					***0.068***	***0.013***	***0.001***	***5.583***	***11.646***	***0.353***	***0.008***	***0.003***	***2.245***	***0.407***	***2.202***	***0.051***

Table 6.18: Summary of pressure footprints identified for TraC water bodies within the WRBD. Expressed as a proportion of the total RBD TraC water body area

Water Body Code	Water Body Name	Water Body Type	Area (km^2)	Perimeter (km^2)	Land claim - High Impact	Land claim - Low Impact	Dredging - High Impact	Dredging - Low Impact	Other Disturbances to Seabed	Disposal at Sea	Flow and Sediment Manipulation Structures	Piled Structures	Shoreline Reinforcement - High Impact	Shoreline Reinforcement - Low Impact	Embankments	Causeways
WE_010_0000	Aran Islands, Galway Bay, Connemara (HAs 29;31)	CW2	1038.2298	426.3250	0	0	0	30.5186	546.5537	0.1700	0.0305	0	3.360	0	0	0
WE_130_0000	Aughinish Bay	CW8	5.5346	33.7320	0	0	0	0	5.5313	0	0	0	1.102	0	0	0
WE_300_0000	Ballynakill Bay	CW5	24.8998	67.2850	0.0037	0	0	0	11.0064	0	0.0033	0	0	0.604	0	0
WE_460_0000	Ballysadare Bay	CW8	8.3176	22.2120	0	0	0	0	0	0	0	0	0	0	0	0
WE_110_0000	Ballyvaghan Bay	CW5	10.6280	39.0160	0	0	0	0	10.6248	0	0.0019	0	1.735	0	0	0
WE_380_0000	Bellacragher Bay	CW8	7.5485	51.7270	0	0	0	0	0	0	0	0	0	0	0	0
WE_405_0000	Belmullet Bay	CW8	9.4401	28.6620	0	0	0	0	0	0	0	0	0	0	0	0
WE_230_0000	Bertraghboy Bay	CW5	37.6937	95.2400	0	0	0	0	37.6908	0	0.0076	0	0.146	0	0	0
WE_360_0000	Blacksod Bay	CW5	240.8847	179.9990	0	0	0	0	33.2100	0	0	0	0	0	0	0
WE_370_0000	Blacksod Bay SW / Achill Sound	CW5	38.1681	112.0090	0	0	0	0	4.6948	0	0	0	0	0	0	0
WE_400_0000	Broadhaven	CW5	57.3752	82.3970	0	0	0	0	1.7349	0	0	0	0	0	0	0
WE_420_0200	Cartoon Lough, Killala Bay	CW10	0.0298	1.1620	0	0	0	0	0	0	0	0	0	0	0	0
WE_190_0000	Casla Bay	CW5	9.1956	40.9950	0.0208	0	0	0	0.1665	0	0.0244	0	0.435	0	0	0
WE_340_0000	Clew Bay	CW2	198.4143	76.9270	0	0	0	0	146.7622	0.1138	0.0006	0	0	0	0	0
WE_430_0000	Donegal Bay Southern	CW2	573.0911	153.4010	0	0	0	106.0618	0	0	0	0	0	0	0	0
WE_350_0000	Inner Clew Bay	CW5	65.1723	203.2520	0	0	0	0.0125	65.0898	0	0	0	0	0	0	0
WE_170_0000	Inner Galway Bay North	CW5	37.4363	68.0850	0	0	0	2.7888	11.2693	0	0.0027	0.0010	1.252	0	0	0
WE_160_0000	Inner Galway Bay South	CW5	45.1864	80.8610	0	0	0	0.5548	37.6275	0	0.0017	0.0005	0.052	0	0	0
WE_200_0000	Kilkieran Bay	CW5	82.4779	276.3750	0	0	0	0	82.4505	0	0.0287	0.0038	0.811	0	0	1.013
WE_420_0000	Killala Bay	CW5	81.3774	68.0450	0	0	0	8.7495	0	0	0.0041	0	0	0	0	0
WE_310_0000	Killary Harbour	CW5	12.6891	53.1480	0.0104	0.0100	0	0	2.0778	0	0.0047	0.0004	0	0	0	0
WE_200_0100	Lettermullen Pool	CW10	0.0059	0.4150	0	0	0	0	0.0059	0	0.0001	0	0	0	0	0
WE_260_0000	Mannin Bay	CW5	9.8712	25.6890	0	0	0	0	9.8074	0	0.0008	0	0.088	0.085	0	0
WE_100_0000	Outer Galway Bay	CW2	136.7259	50.7450	0	0	0	9.5006	59.1037	0	0.0038	0	0.631	0.171	0	0
WE_460_0200	Portavaud East, Ballysadare Bay	CW10	0.0234	1.2390	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0710	Rincarna Pools North	CW10	0.0061	0.3730	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0700	Rincarna Pools South	CW10	0.0050	0.2900	0	0	0	0	0	0	0	0	0	0	0	0
WE_450_0000	Sligo Bay	CW5	81.7929	61.7950	0	0	0	36.0427	0	0	0	0	0	0	0	0
WE_470_0000	Sligo Harbour	CW8	8.0719	21.2450	0	0	0	0.4848	0	0	0	0	0	0	0	0
WE_250_0000	Western Atlantic Seaboard (HAs 32;33;34)	CW2	1754.1624	910.7680	0	0	0	3.6208	72.9662	0.1700	0.0094	0	0.636	0	0	0
Total area / length of coastal water bodies and pressure footprints			***4574.46***	***3233.41***	***0.03***	***0.01***	***0.00***	***198.33***	***1138.37***	***0.45***	***0.12***	***0.01***	***10.25***	***0.86***	***0.00***	***1.01***
Coverage of pressure footprints per coastal water body area / length (%)					***0.001***	***0.000***	***0.000***	***4.336***	***24.885***	***0.010***	***0.003***	***0.000***	***0.317***	***0.027***	***0.000***	***0.031***
WE_170_0300	Ardfry Oyster Pool	TW6	0.0569	1.3460	0	0	0	0	0	0	0	0	0	0	0	0
WE_140_0100	Aughinish Lagoon	TW6	0.0509	1.3210	0	0	0	0	0	0	0	0	0	0	0	0
WE_055_0100	Baile an Duin Lagoon	TW6	0.0035	0.2950	0	0	0	0	0	0	0	0	0	0	0	0
WE_240_0100	Ballyconneely Lough	TW6	0.1819	3.1020	0	0	0	0	0	0	0	0	0	0	0	0
WE_460_0300	Ballysadare Estuary	TW2	8.7174	25.9450	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0200	Bridge Lough, Knockakilleen	TW6	0.0832	2.7360	0	0	0	0	0.0829	0	0	0	0	0	0	0
WE_410_0100	Bunatrahir Bay	TW2	1.2668	5.0420	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0200	Camus Bay	TW2	10.7493	84.5150	0	0	0	0	6.4867	0	0.0029	0	0	0	0	0
WE_140_0200	Carrownahallia Lagoon, Aughinish	TW6	0.0017	0.1610	0	0	0	0	0	0	0	0	0	0	0	0
WE_190_0100	Casla Estuary	TW2	0.0151	0.6610	0	0	0	0	0	0	0	0	0	0	0	0
WE_270_0100	Clifden Bay	TW2	6.5681	33.3320	0.0104	0	0	0	3.9678	0	0.0019	0.0009	0.394	0	0	0
WE_420_0100	Cloonaghmore Estuary	TW2	0.5126	7.3610	0	0	0	0	0	0	0	0	0	0	0	0
WE_320_0100	Corragaun Lough	TW6	0.2393	3.5760	0	0	0	0	0	0	0	0	0	0	0	0
WE_170_0700	Corrib Estuary	TW2	9.6586	27.7270	0	0	0	1.0167	1.6362	0.1832	0.0209	0.0046	6.977	0.101	0	1.675
WE_370_0100	Dooniver Loughs	TW6	0.0262	0.9000	0	0	0	0	0	0	0	0	0	0	0	0
WE_480_0100	Drumcliff Estuary	TW2	4.0330	9.9720	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0800	Dunbulcaun Bay	TW2	2.0529	17.6120	0	0	0	0.0064	2.0513	0	0.0017	0	0	0	0	0
WE_440_0100	Easky Estuary	TW2	0.0346	1.0930	0	0	0	0	0	0	0	0	0	0	0	0
WE_310_0100	Erriff Estuary	TW2	0.4140	5.6050	0	0	0	0	0	0	0.0002	0	0	0	0	0
WE_350_0300	Furnace Lough	TW6	1.6764	15.6640	0	0	0	0	0	0	0	0	0	0	0	0
WE_470_0100	Garavoge Estuary	TW2	8.8254	21.4420	0.2068	0	0	0.9795	0	0	0	0	0	0	0	0
WE_160_0100	Kinvarra Bay	TW2	5.7272	37.3030	0	0	0	0	5.7239	0	0.0047	0	0.059	0.262	0	0
WE_090_0100	Loch Amurvy, Arainn	TW6	0.0019	0.2260	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0700	Loch an Aibhinn, Camus Bay	TW6	0.5425	6.1200	0	0	0	0	0.0056	0	0	0	0	0	0	0
WE_210_0100	Loch an Chaorain (L. Keeraun)	TW6	0.0142	0.7760	0	0	0	0	0	0	0	0	0	0	0	0
WE_060_0100	Loch an Chara, Arainn	TW6	0.0204	1.2420	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0400	Loch an Ghadai	TW6	0.0461	1.1120	0	0	0	0	0	0	0	0	0	0	0	0
WE_260_0100	Loch an tSaile (Lough Athola), Mannin Bay	TW6	0.1131	3.2050	0	0	0	0	0	0	0	0	0	0	0	0
WE_050_0100	Loch an tSaile, Arainn	TW6	0.0034	0.2460	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_1100	Loch an tSaile, North of Camus Bay	TW6	0.8994	15.0720	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0800	Loch Cara Fionnla	TW6	0.1374	2.9070	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_1200	Loch Conaortha (L. Aconeera)	TW6	0.2368	2.7340	0	0	0	0	0	0	0	0	0	0	0	0
WE_080_0100	Loch Dearg, Arainn	TW6	0.0098	0.3990	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_1000	Loch Doire Bhanbh (Derravonniff)	TW6	0.0123	0.4800	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0500	Loch Fhada	TW6	0.0865	2.6940	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0300	Loch Fhada Upper Pools	TW6	0.0108	0.9760	0	0	0	0	0	0	0	0	0	0	0	0
WE_020_0100	Loch Mor, Inis Oirr	TW6	0.0655	1.4150	0	0	0	0	0	0	0	0	0	0	0	0
WE_040_0100	Loch na gCadhan, Inis Meain	TW6	0.0171	0.8980	0	0	0	0	0	0	0	0	0	0	0	0
WE_070_0100	Loch Phort Chorruch, Arainn	TW6	0.0305	1.0550	0	0	0	0	0	0	0	0	0	0	0	0
WE_200_0600	Loch Tanai	TW6	0.0959	2.2300	0	0	0	0	0	0	0	0	0	0	0	0
WE_220_0100	Lough an Mhuilinn (Mill Lough)	TW6	0.0573	2.0560	0	0	0	0	0	0	0	0	0	0	0	0
WE_290_0100	Lough Anillaun, Cleggan Bay	TW6	0.1135	2.5290	0	0	0	0	0	0	0	0	0	0	0	0
WE_280_0100	Lough B Finne, Inishbofin	TW6	0.0808	1.3010	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0400	Lough Fadda (Doorus Loughs)	TW6	0.0040	0.3310	0	0	0	0	0	0	0	0	0	0	0	0
WE_190_0200	Lough Faddacrussan	TW6	0.0182	0.8470	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0500	Lough Namona (Doorus Loughs)	TW6	0.0076	0.4650	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0600	Lough Sallagh (Doorus Loughs)	TW6	0.0056	0.3890	0	0	0	0	0.0055	0	0	0	0	0	0	0
WE_170_0200	Loughaunascalia, Ardfry Point	TW6	0.0042	0.2720	0	0	0	0	0	0	0	0	0	0	0	0
WE_160_0300	Loughaungreena (Doorus Loughs)	TW6	0.0017	0.1920	0	0	0	0	0	0	0	0	0	0	0	0
WE_420_0300	Moy Estuary	TW2	7.4168	39.4450	0	0	0	0.6457	0	0	0.0002	0	0	0	0	0
WE_110_0100	Muckinish Lough	TW6	0.0258	0.9930	0	0	0	0	0	0	0	0	0	0	0	0
WE_120_0100	Murree Lough	TW6	0.1307	1.5620	0	0	0	0	0	0	0	0	0	0	0	0
WE_170_0150	Mweeloon Pool North	TW6	0.0042	0.2690	0	0	0	0	0	0	0	0	0	0	0	0
WE_170_0100	Mweeloon Pool South	TW6	0.0043	0.2710	0	0	0	0	0.0035	0	0	0	0	0	0	0
WE_350_0200	Newport Bay	TW2	9.3457	61.3160	0	0	0	0.0012	9.3186	0	0	0	0	0	0	0
WE_170_0500	Oranmore Bay	TW2	3.5475	18.3040	0	0	0	0	0	0	0.0007	0	0	0	0	0
WE_030_0100	Port na Cora lochs, Inis Meain	TW6	0.0041	0.5510	0	0	0	0	0	0	0	0	0	0	0	0
WE_460_0100	Portavaud West, Ballysadare Bay	TW6	0.0103	0.7570	0	0	0	0	0	0	0	0	0	0	0	0
WE_170_0600	Renmore Lough, Galway City	TW6	0.0105	0.7860	0	0	0	0	0	0	0	0	0	0	0	0
WE_330_0100	Roonagh Lough	TW6	0.4265	3.9350	0	0	0	0	0	0	0	0	0	0	0	0
WE_150_0100	Rossalia Lagoon	TW6	0.0156	0.5800	0	0	0	0	0	0	0	0	0	0	0	0
WE_230_0100	Roundstone Bay	TW2	7.5691	48.0360	0	0	0	0	6.9810	0	0.0048	0	0.311	0	0	0
WE_180_0100	Spiddal Estuary	TW2	0.0626	1.1720	0	0	0	0	0.0626	0	0.0041	0	0.091	0	0	0
WE_400_0200	Sruwaddacon Bay	TW2	8.3928	42.5220	0	0	0	0	0	0	0	0	0	0	0	0
WE_460_0400	Tanrego Intake	TW6	0.0156	0.5930	0	0	0	0	0	0	0	0	0	0	0	0
WE_390_0100	Tullaghan Bay	TW2	17.2475	66.5860	0	0	0	0	0	0	0	0	0	0	0	0
WE_170_0400	Turreen Lough (Rinville West)	TW6	0.0230	1.0070	0	0	0	0	0	0	0	0	0	0	0	0
WE_350_0100	Westport Bay	TW2	15.3237	63.5400	0	0	0	0	15.1814	0	0	0	0	0	0	0
Total area / length of coastal water bodies and pressure footprints			***133.11***	***711.11***	***0.22***	***0.00***	***0.00***	***2.65***	***51.51***	***0.18***	***0.04***	***0.01***	***7.83***	***0.36***	***0.00***	***1.67***
Coverage of pressure footprints per coastal water body area / length (%)					***0.163***	***0.000***	***0.000***	***1.990***	***38.696***	***0.138***	***0.032***	***0.004***	***1.101***	***0.051***	***0.000***	***0.236***
Total RBD area / length			***4707.56***	***3944.52***	***0.252***	***0.010***	***0.000***	***200.984***	***1189.881***	***0.637***	***0.166***	***0.011***	***18.080***	***1.223***	***0.000***	***2.688***
Coverage of pressure footprints per RBD area / length (%)					***0.005***	***0.000***	***0.000***	***4.269***	***25.276***	***0.014***	***0.004***	***0.000***	***0.458***	***0.031***	***0.000***	***0.068***

7. GOOD PRACTICE REVIEW FOR MORPHOLOGICAL MITIGATION MEASURES

7.1 Introduction 1
7.2 Key Definitions and Concepts 2
7.2.1 WFD Morphological Conditions in Transitional and Coastal Waters 2
7.2.2 Conceptual frameworks for restoration and recovery in TraC environments 2
7.3 Review Process 4
7.3.1 Information Reviewed 4
7.4 Potential Types of Measures 8
7.5 Contents and use of the accompanying spreadsheet (Appendix 7-1) 9
7.6 Identifying Potential Measures 10
7.6.1 Applying the good practice guidance 10
7.6.2 Information on costs/cost effectiveness 10
7.6.3 A decision-making framework to select measures 13

7.1 Introduction

This review brings together existing information on ‘good practice measures’ for activities which involve hydromorphological alterations to transitional or coastal waters. It is part of the Marine Morphology Literature Review, and has been included to provide initial guidance supporting the first round of RBMPs, specifically in defining POMs. Lessons learnt during the first phase of planning could be used to update and refine this preliminary guidance in the future.

This summary report and accompanying spreadsheet (Appendix 7-1) guide the user/reader to sources of information which can aid decisions for identifying which mitigation measures should be put in place to aim to ensure no deterioration in ecological status for new developments, or to identify measures to address existing modifications that will enable a water body to achieve its environmental objective under the WFD.

A generic decision guidance process has been produced, based on an outline given in the EU CIS (2006) technical report on hydromorphological alterations. The approach does not intend to produce prescriptive guidance in terms of the design or implementation of measures.

The report introduces some key concepts, summarises the types of information available and introduces what are considered to be potential measures to address hydromorphological pressures in transitional and coastal water bodies. The detailed content has been collated in an appended spreadsheet which links morphological pressures to mitigation measures, literature and guidance summaries, case studies and internet website links.

7.2 Key Definitions and Concepts

7.2.1 WFD Morphological Conditions in Transitional and Coastal Waters

The WFD identifies a series of 'quality elements' for biological, physico-chemical and hydromorphological components of all water bodies. These are used to monitor the status/quality of waters and therefore will be used as a baseline from which to assess and document the success of the PoMs which will be put in place for each RBD.

Measures related to morphology in TraC waters will be those that seek to prevent deterioration, maintain status/quality, or 'restore' conditions, related to:

- Depth variation
- Structure and substrate of the subtidal bed
- Structure of the intertidal zone

The hydrological elements are strongly connected with these and include the direction of dominant currents, the degree of wave exposure, and the amount of freshwater flow in estuaries.

Any activity which may impact on or alter these conditions is considered to be a pressure. These are listed in the accompanying spreadsheet together with the general impacts on morphological conditions. One pressure which has not been directly included is where potential mitigation measures may themselves result in direct or indirect changes to morphological conditions; for example one measure that has been suggested to reduce the frequency of dredging operations in estuaries is the use of training walls to promote self-scouring - however this may impact on all three of the morphological elements listed above.

7.2.2 Conceptual frameworks for restoration and recovery in TraC environments

Restoration may involve the recovery/reattainment of physical, chemical and biological environments by either active management interventions, or by passive means (natural recovery). These states imply re-establishing sustainable habitat with natural structure and function, essentially a return to a previous (pre-disturbance) condition in which a successful and sustainable ecological community can be maintained. The baseline for the original conditions present within a water body may not be known or achievable.

It is generally accepted that a greater body of research and evidence exists in the recovery of freshwater ecosystems, where practices are more formalised and advanced than in the estuarine and coastal situation where examples are more recent, and the complexity of the systems perhaps means that the range of useful techniques is more constrained. Also, techniques rarely directly replace 'lost' habitats, but more frequently aim to create a 'compensatory' habitat. Elliott ***et al*** (2007) suggest that the process of removing pressures to promote natural recovery (by passive means) would be the most effective approach in estuarine and coastal locations, but this may not be possible given the importance of other 'uses'. Weinstein and Reed (2005) refer to the 'dual mandate' whereby there is a conflict in attempting to manage natural dynamic environments to a human environment that demands predictability and stability. The WFD addresses this discord by allowing less stringent objectives to be set in heavily modified environments where development or industry exists.

Some environments have a higher resistance or resilience to change, and also may be able to recover naturally from pressure or stress if the pressure is removed. For example, a dynamic feature in a high energy environment such as a mobile subtidal sandbank may recover more rapidly with no intervention. However some features may require management interventions to replace structural or functional elements, in an attempt to improve on a degraded state. The terms rehabilitation, restoration and remediation have been used to describe these practices, and may involve measures required to address pressures that have already impacted on estuarine or coastal waters. Management actions for rehabilitation or restoration may involve managed realignment, dock restoration, saltmarsh restoration or beach restoration, but may often be 'compensatory' or 'offsetting' measures which do not directly address or alter the initial pressure.

For new/planned interventions, the focus will be on 'mitigation'; making any predicted/potential impacts on morphology less severe. Elliott and Cutts (2004) suggest that mitigation is easily achieved for pressures such as pollution, dredging and disposal or temporary structures, whereas the construction of permanent structures would more likely require the 'offsetting' type measures indicated above.

A key (and currently only partially substantiated) assumption is that protecting or restoring morphological conditions will provide the required conditions to support the ecological elements (communities of benthic invertebrates, fish, angiosperms and phytoplankton). Research into these links is ongoing and likely to be informed by ongoing monitoring for the WFD.

7.3 Review Process

The review was undertaken by searching for and consulting a wide variety of different types of literature. The majority of the review was conducted using readily accessible internet sources (websites or downloaded documents). These documents (usually Adobe PDF files) can be accessed by hyperlinks in the spreadsheet. Some key relevant guidance manuals are copyrighted or are only available in hard copy. For these documents, a reference has been included but there is no active hyperlink.

Very little information was found that was produced in, or directed specifically at, the RoI. However, it is assumed that experience gained in Northern Europe, and more so the UK, will be relevant to the Irish situation.

7.3.1 Information Reviewed

A variety of different types of information were found to be available. It is helpful to split these into some general categories:

Legislation-related guidance (e.g. EU CIS and UK TAG guidance papers)

These are reports produced by various working groups concerned with implementation of the WFD, including members of the competent authorities, and representatives from sectors such as the ports and navigation industries. Many have been produced at various stages of the WFD timetable, the most relevant being the 2006 EU CIS technical report on 'WFD and Hydromorphological Pressures (Good practice in managing the ecological impacts of hydropower schemes; flood protection works; and works designed to facilitate navigation)'. The report and appendix of case studies aims to provide guidance and good practice examples of prevention, remedies and mitigation for the ecological effects of impacts of activities. Information has been gathered from practitioners across the EU to address current alterations and future pressures. However there are only limited examples for Transitional and Coastal water bodies (and indeed lakes) – the main focus is on rivers.

Scientific papers/journal articles

A substantial body of scientific literature exists on ecosystem restoration, particularly from American experiences of wetland restoration. Journal articles, whether written by academics or practitioners, are peer-reviewed and represent current thinking. Case study-type articles are the most common, while reviews of particular techniques or of concepts in management provide a more generic viewpoint. The most practically useful articles are probably those written in journals written by and aimed at the engineering sector such as the Proceedings of the Institution of Civil Engineers (Engineering Sustainability; Maritime Engineering), and the Chartered Institute of Water and Environmental Management (CIWEM) Water and Environment Journal, while relevant research and academic concepts are found in Estuarine, Coastal and Shelf Science, Aquatic Conservation (Marine and Freshwater Ecosystems), Restoration Ecology, Estuaries, Marine Pollution Bulletin etc. Journal abstracts are free to search through using web search engines such as ScienceDirect or Google Scholar, but full text versions may have to be purchased.

Conference and seminar presentations/papers

Presentations given at conferences and seminars are increasingly being published on the relevant website after the event. Many presentations are made – but the resulting outputs from them are not peer-reviewed to give the same level of confidence in their results as with scientific literature. However, they often give a good summary of the latest thinking on a specific topic.

Project Reports and Environmental Impact Statements

In some cases, detailed project reports may be available including information about design aspects and monitoring success – sometimes they may be available on the internet. If available, EIAs of similar works may state generic and more specific mitigation measures. It is difficult to ascertain whether specific project reports and the mitigation types stated therein represent Good or Best Practice. It is also difficult to draw generic good practice lessons from project specific situations. A full review of EISs was undertaken as part of the wider Literature Review, rather than for this Good Practice Section. The EIS information obtained included various types of estuarine and coastal projects in Ireland from 1989-2005. Almost all of these projects stated some type of mitigation to reduce or remove impacts related to water quality/pollution or morphology (or knock-on impacts on ecology). 33 types of mitigation addressing morphology were included, not all of these were 'mutually exclusive'. The most common of these were:

- Do not disturb sensitive areas (8 quotes);
- Minimise the construction/reclamation area (10 quotes);
- Correct choice of dredging equipment and methods (12 quotes);
- Ensure sediment release during dredging is monitored/controlled (7 quotes).

Table 7.1 below conveys the distribution of measures related to morphology that have been quoted in Irish EISs as reviewed for the Literature Review.

Table 7.1: list of mitigation measures from environmental statements for coastal and estuarine works in Ireland (1989-2005)

Mitigation Type	Number of References
Limit length of impoundment	1
Maintain natural tidal cycles	1
Settling ponds	2
Construction works during low tide	1
Minimise area of extraction	2
Undertake baseline surveys	2
Do not disturb sensitive areas	8
Saltmarsh/intertidal habitat creation	2
Minimise construction/reclamation area	10
Choice of dredging equipment/methods	12
Avoid sensitive time of year for fish/mussels	5
Undertake environmental monitoring	6
Onshore disposal of dredgings	2
Restoration of disturbed habitats	3
Suitable dredge-dump sites	5
Control amount of sediment released	7
Good site management	3
Shingle/sediment bypassing	2
Turbidity monitoring	3
Permeable bunding to reduce mudflat erosion	2
Beneficial use of dredgings	3
Ecological surveys	3
Silt traps	4
Reprofile seabed after dredging	1
Sympathetic design of structures	3
Compensatory habitat	1
Temporary fencing	1
Limit duration of works	1
Fish pass	1
Recreate/restore shellfish beds	2
Avoid periods of bad weather	1
Debris management	1
Minimise need for future dredging	1

Case studies

The review incorporates a series of case study examples – learning from positive and negative past experiences can be extremely beneficial. However, due to the case specific nature of such information, it is better to canvas for general 'lessons learned' rather than for specific guidance. It is also likely that successes are more widely reported than failures. Case studies can be found within the bodies of other literature including guidance manuals, technical documents, journals and widely on the internet (through either information gateways or dedicated sites). For example, the 'Online Managed Realignment Guide' (www.abpmer.net/omreg) contains a searchable database of over 80 UK and European schemes.

CIRIA (and similar) guidance manuals

CIRIA (Construction Industry Research and Information Association) manuals are acknowledged in the UK as principal sources of information for practitioners across many engineering disciplines. Two manuals have been published on relevant topics and have been reviewed; The Beach Management Manual (1996 but currently being updated) and Coastal and Estuarine Managed Realignment, Design Issues (2004). These aim to 'share knowledge and best practice' and contain theoretical background and guidance on the whole project and design process. Other manuals have been published by interest groups such as RSPB, and there is a recent move towards mounting information on accessible web-based platforms (for example the Saltmarsh Manual www.saltmarshmanagementmanual.co.uk and the Managed Realignment Electronic Platform www.intertidalmanagement.co.uk which are sponsored by the Environment Agency (EA).

Codes of Practice (e.g. Ports sector)

Voluntary 'Codes of Practice' are a potential measure promoted by initial research into measures required for the WFD. They can also provide useful sources of information, particularly in relation to the experiences of the Ports sector. Port infrastructure and navigation are two of the key drivers and activities which may need to be mitigated to achieve WFD objectives for TraC waters. The port sector has been actively involved in drawing up codes of practice, (for example ESPO (European Sea Ports Organisation) 1994 (revised 2003), and in 2007 published a code specifically related to the Birds and Habitats Directives). These contain useful information in relation to consenting and mitigating dredging and port construction activities (and wider issues).

7.4 Potential Types of Measures

The sources that have been reviewed indicate that there are numerous established and developing techniques, which have more generally been brought into use through general good environmental practices, for example identification and mitigation of impacts as part of EIA, or to comply with previous legislation such as the Bird and Habitats Directive. Many of these relate to and could be classed as 'measures' for morphology. These can generally be classified into the following groups:

- General good environmental practice and management plans, for example as summarised in 'Guidelines for Port Environmental Management' (Paipai, 1999) and the uptake of Environmental Management Systems (EMS) and monitoring programmes in Ports, which contain information about the morphological elements, particularly substrates (and also integrate data on biological and chemical/water quality aspects). One example case study given in the appended spreadsheet is the introduction of an EMS at Dover Harbour (UK) (Dover Harbour Board, 2006). These are proving beneficial in identifying appropriate mitigation measures or in adapting management to reduce impacts.

- Mitigation measures, which in the example of dredging can involve planning issues such as the timing, frequency and extent of dredging activities to avoid sensitive locations; using improved technology to minimise suspension of sediment and damage to the bed; and investigation opportunities for 'beneficial' use of sediments for example in recharge of beach or intertidal sediments. A key reference for intertidal habitat management is the CIRIA 2004 manual 'Coastal and Estuarine Managed Realignment - Design Issues'. See also Table 7.1 listing the mitigation measures related to morphology that have been quoted in previous Environmental Statements.

- Restoration measures, the most frequent use of which is to create or recreate intertidal mudflats and saltmarsh succession lost through land claim or coastal development, often through processes of managed realignment

- Natural recovery should also not be discounted as an option, although unlikely to be within the timescales of a round of River Basin Planning, over longer timescales it may be the most cost-effective and sustainable approach.

Detailed information on these measures, including theory and case studies are included in the spreadsheet and the reference links within.

7.5 Contents and use of the accompanying spreadsheet (Appendix 7-1)

The information collected in the literature review has been collated in the appended spreadsheet. The spreadsheet can be printed out but contains a series of links between pages and to external sources, and is therefore best viewed electronically/'interactively'. The information is organised as set out below:

- Pressures and Mitigation Summary: This page summarises the key pressures and impacts on TraC Waters, matched with potential generic mitigation measures. More detail on specific types of mitigation measures can be found in the literature summaries and case studies pages.

- Literature summaries for key documents: This page introduces a set of the most useful documents that refer to good practice for specific mitigation measures and also generally in terms of good environmental management to minimise and identify potential morphological impacts. It can be used to identify whether a particular document contains relevant information as it can be difficult to search for specific information in a lengthy document from the contents list alone.

- Case studies: This page provides details for about 50 case studies, giving evidence of hydromorphological, ecological and cost effectiveness where documented. In all UK examples found, the measures have been carried out on water bodies which are provisionally identified as 'Heavily Modified', rather than on those without existing morphological pressures. Very little information is available on how relevant these measures are for less modified water bodies. Links are given to sources that provide more detailed information/images.

- Web-based Good Practice Information: This page lists the sources of information available on the internet with a summary of the aim of the research project or information available on the website and a hyperlink to the website.

- Full reference list

7.6 Identifying Potential Measures

7.6.1 Applying the good practice guidance

In reviewing generic 'Good Practice', it is important to emphasise that mitigation measures that have proven successful in one location may not be directly applicable in other environments. Most good practice guidance emphasises the need for site-specific investigations and designs in the context of a wider strategy (in this case the strategic scale is led by the RBMP). Important initial considerations of whether mitigation measures are potentially appropriate would include the water body classification type (e.g. a coastal lagoon or a polyhaline, mesotidal estuary) and for HMWB, what the uses are and whether the measure may compromise this use.

7.6.2 Information on costs/cost effectiveness

The WFD has generated a need for RBMPs to assess the 'cost-effectiveness' of various measures, and a number of economics-based research reports have been recently undertaken (or are ongoing), for example the 'Collaborative Research Programme' (CRP), lead by the Department for Environment, Food and Rural Affairs (DEFRA) in England and Wales. Outputs from this programme include developing a methodology to assess disproportionate costs (RPA, 2004) and the development of a database for benchmark costs and guidance on applying cost-effectiveness methodology (Entec, 2006). The latter report contains a worked example for morphological pressures (navigation/port operations) on a coastal water body (p39-51), in which steps 4-6 include issues related to costs.

A scoping report has also been produced with specific focus on economic impacts in TraC waters (Brooke, 2005). This is based on a stakeholder workshop, and concludes that the financial and economic implications for sectors operating in TraC waters could be significant. Measures which might be achievable at minimum cost typically include the development or application of codes of good practice, better enforcement of (often existing) local regulation, some zoning initiatives, and various research initiatives. Potential measures involving anticipated moderate costs (i.e. neither minimal nor necessarily significant) include some research initiatives, required modifications (whether to plant, gear or working methods) and/or certain types of constraints imposed on activities by regulatory bodies (for example some seasonal restrictions or constraints on working methods). Depending on the detail, measures prohibiting certain activities or working methods (e.g. certain dredging techniques) may be shown to be disproportionately costly, particularly if the full range of consequential costs is considered in the analysis.

Costing of individual measures is difficult for a number of reasons: the lack of available and up to date data (often information is confidential and related to contracts, e.g. costs of dredging in ports); the geographical scale of implementation required; site specific details and the necessary costs of feasibility and design; and, the associated costs of legislative or other mechanisms to implement the measures, are key examples. Table 7.2 summarises quantitative and qualitative cost information for specific examples that have been obtained from case studies or other documentation as part of this review. More information on the project details is available in case studies in the appended spreadsheet.

Table 7.2: Quoted costs of specific examples for a limited number of measures

Measure	Specific Example	Quoted Costs
Saltmarsh erosion protection	Oosterschelde Estuary, SW Netherlands. Construction of low stone dam along saltmarsh. (CIS, 2006)	€500,000 to protect 4-5 km of saltmarsh. Also protects dykes and polders from wave attack.
Flood bank breach	Hullbridge, River Crouch, Essex, England. Breaching a low flood bank to create compensatory intertidal habitat for essential flood defence works. (CIS, 2006)	€1.5m approx (including flood defences).
Environmental Information Systems	Thames Estuary, England. Establishing framework for decision-making including stakeholder dialogue, GIS information exchange system. (CIS, 2006)	£100,000 set-up, £15,000 per year costs, £100,000 projected annual savings.
Managed realignment scheme appraisal and design	Alkborough Flats, Humber Estuary, England. Creation of 440 hectares of intertidal, freshwater and wetland habitats when earth embankments breached. (www.frameproject.eu)	Significant appraisal and design costs compared to construction costs.
Re-introduction of tidal processes	Breebaart Polder, Ems-Dollart Estuary, Netherlands. Restore brackish area with natural processes by reinstating a former watercourse and re-introducing partial/controlled tidal processes. (CIS, 2006)	€1.8m.
Removal of short sections of bank protection	River Elbe, near Hamburg, Germany. Short sections of hard bank protection removed to partially restore natural bank profiles and tidal zoned habitats. (CIS, 2006)	Low cost.
Beneficial use of dredged sediment (small scale intertidal restoration)	Maldon, Blackwater Estuary, Essex, England. Small-scale restoration of eroded saltmarsh, direct placement of dredged material to raise foreshore level. (RSPB/CIWEM, 2005)	Simple, small-scale works, relatively inexpensive as sediment was available locally.
Seawall breach	Nigg Bay, Highlands, Scotland. 2 breaches in seawall, a relic creek system still existed so this was used rather than new earthworks. (RSPB/CIWEM, 2005)	Land acquisition plus £50,000.
Regulated tidal exchange system	Goosemoor, Exe Estuary, Devon, England. Self-regulating tidegate and culvert through river wall. (RSPB/CIWEM, 2005)	£100,000 estimate.
Mudflat sedimentation fences	Wellhouse, West Mersea, Essex, England. Rows of double wooden stakes filled with brushwood were constructed running perpendicular to the shore. Fence length, varied between 20-80 metres. (www.saltmarshmanagementmanual.co.uk)	Economic justification questionable due to low value of land.
Environmental monitoring of dredging activities	Harwich Haven, England. Bathymetric surveys to monitor sediment dispersal. (CIS, 2006)	£150,000 annually.
Water column recharge	Harwich Haven, England. Water column recharge of dredged material to mitigate loss of intertidal habitat by capital and maintenance dredging. (CIS, 2006)	Similar costs to sea disposal of dredging.

A measure with more reported cost information available (partly due to the high public profile of such schemes) is managed realignment. Collection and dissemination of project information has been undertaken as part of the 'Online Managed Realignment Guide' (ABPmer, 2007). For 28 schemes undertaken in the UK, the costs per hectare are given in Figures 7.1 and 7.2). This also indicates the huge variation in costs according to the scale of site and increasing technical complexity. Many of the costs of such schemes are associated with feasibility and design studies and land purchase, rather than construction costs.

Figure 7.1: Reported cost of estuarine/coastal managed realignment sites less than 20 hectares in area

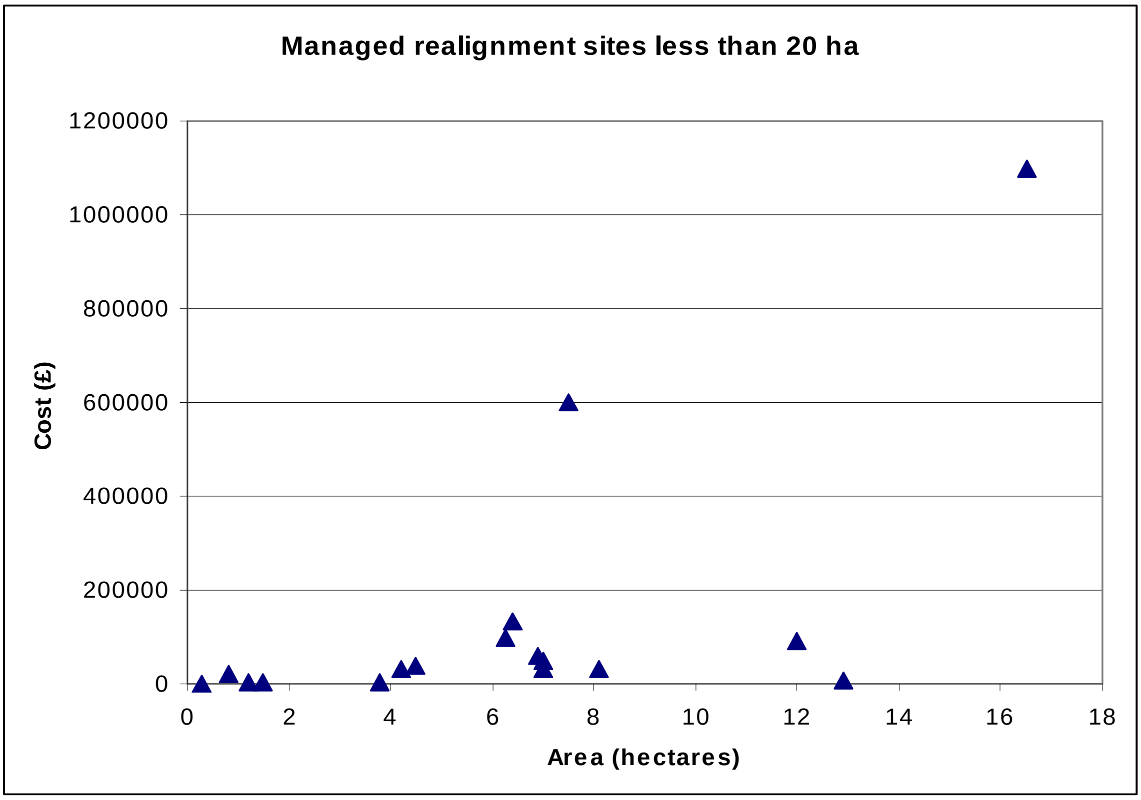
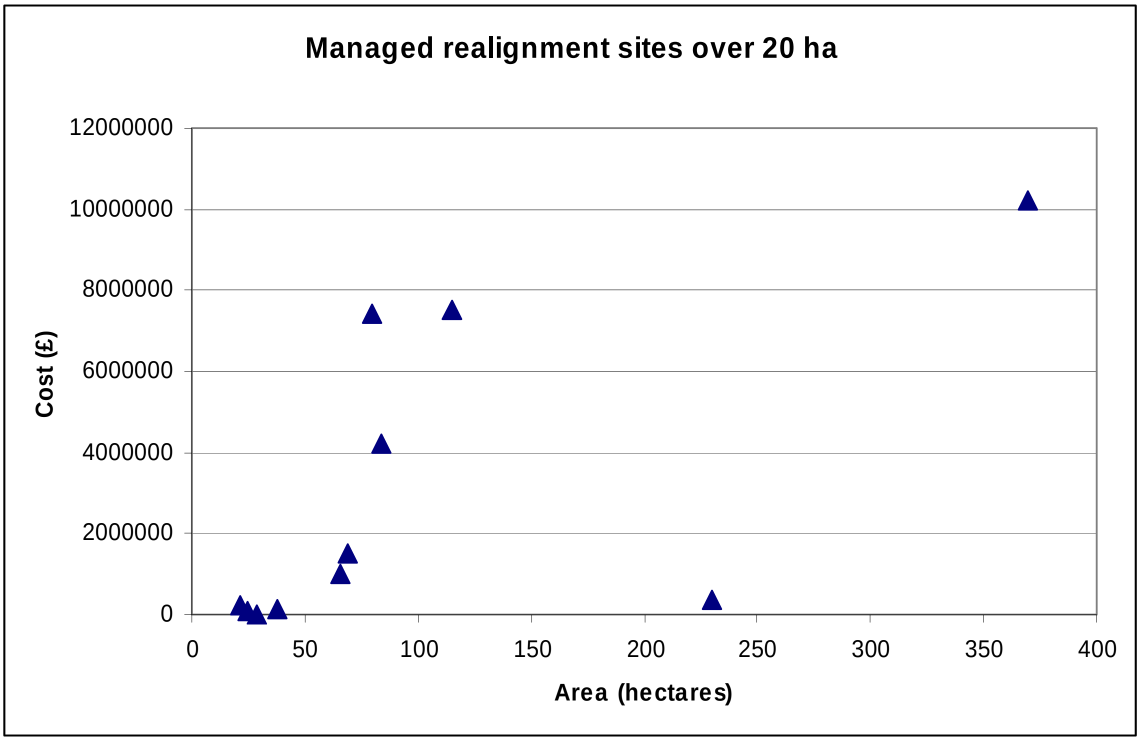


Figure 7.2: Reported cost of estuarine/coastal managed realignment sites greater than 20 hectares in area



7.6.3 A decision-making framework to select measures

The flow diagrams below illustrate a decision-making framework to assess which measures may be applicable for existing modifications (e.g. to improve morphological conditions to achieve the environmental objectives) (Figure 7.3), and for new proposals or ongoing activities (e.g. to prevent deterioration) (Figure 7.4). This is the current recommended approach, based on recent EU guidance (CIS, 2006) but the principles applied may evolve further. Project WFD54 (on the effectiveness of measures, SNIFFER, 2006) includes worksheets to assess measures in terms of the magnitude and certainty of effects, the speed of their effect, durability, adaptability, practicability and possible side-effects.

Additionally, consideration will need to be given to implementation (time exemption, prioritisation in combination with other measures such as cost and the likelihood of a measure being disproportionately costly).

Figures 10.2 and 10.3 of Chapter 10 expand further on the applicability of the framework outlined in Figure 7.3 by recommending steps to prioritise water bodies for the application of appropriate measures.

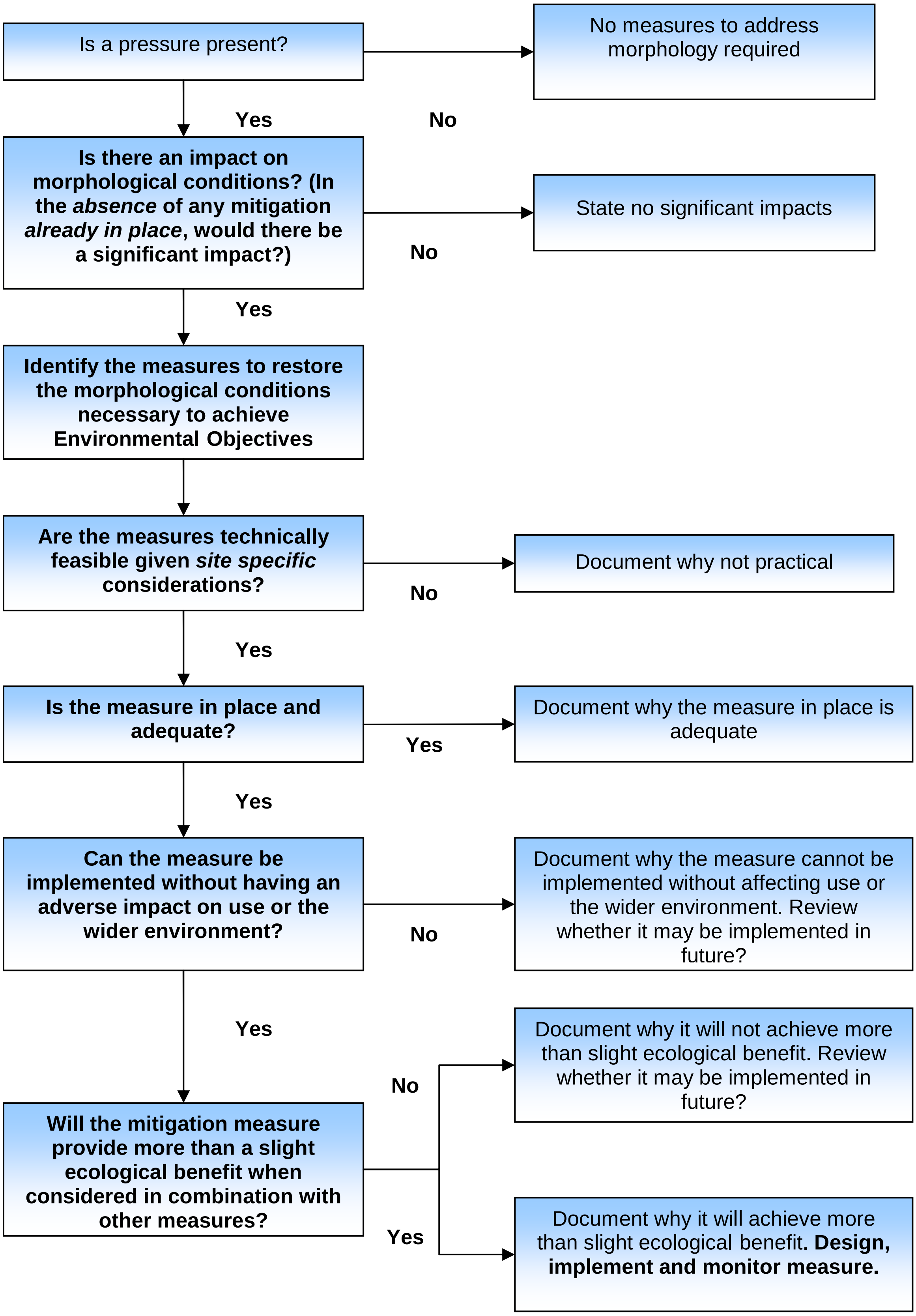


Figure 7.3: Overall framework for using measures to achieve Environmental Objectives for existing modifications or ongoing activities (derived using CIS, 2006)

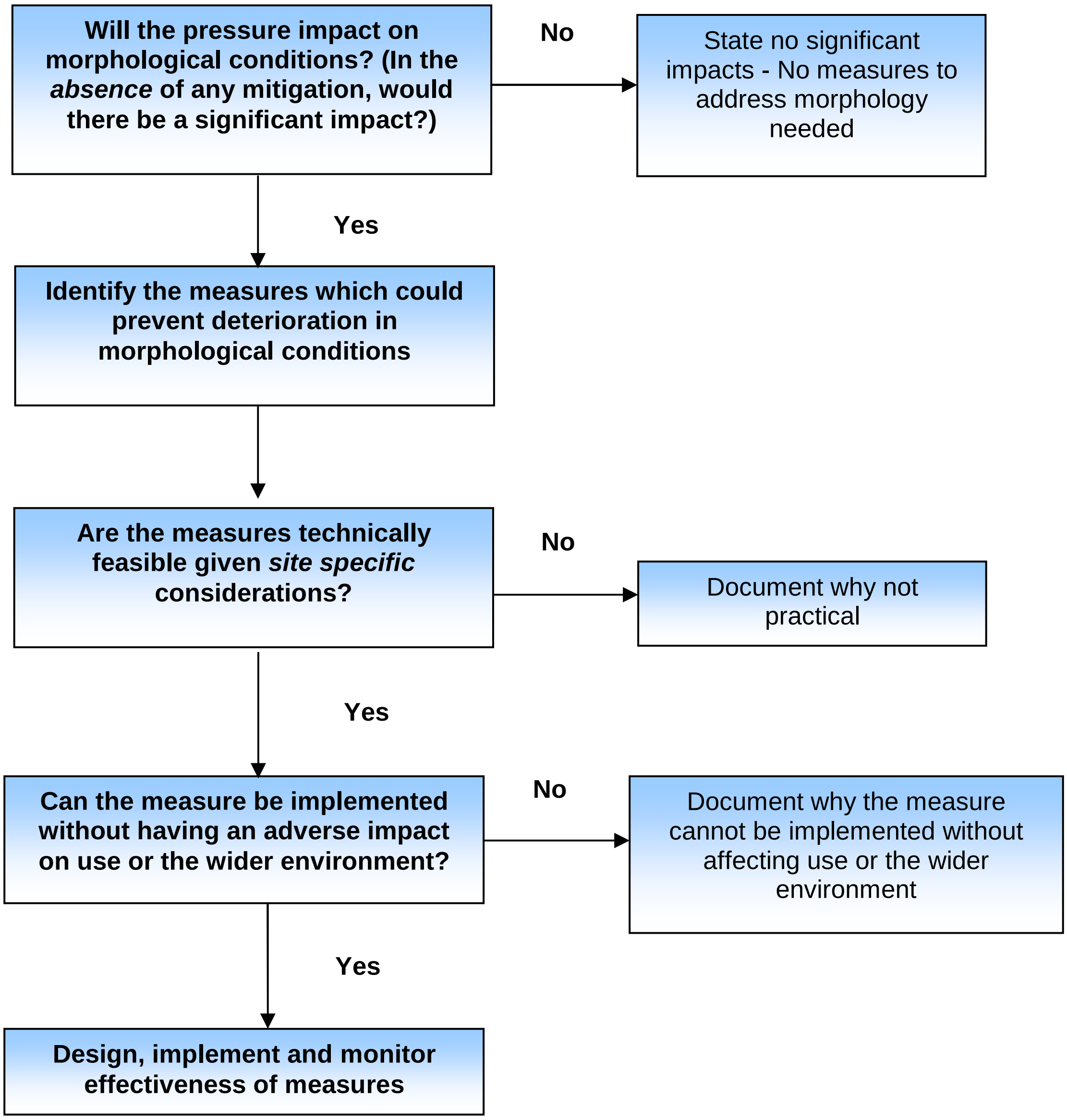


Figure 7.4: Overall framework for using measures to achieve Environmental Objectives for new proposals that may include modifications to morphology (derived using CIS, 2006)

8 FUTURE TRENDS

8.1 Introduction

The WFD requires the projection of risk to a water body failing to achieve good ecological status by 2015. There is therefore a need to analyse not only existing pressures, but also those that potentially occur in the future that may impact on transitional or coastal waters.

Scope

A wide range of sources were consulted to undertake a strategic review to identify potential developments across a range of sectors/pressures which could impact on morphological conditions. This review assumes that population growth in coastal counties will lead to some degree of pressure for development, but it is not in the scope of this report to quantify these pressures. The pressures considered are those affecting physical modifications to transitional and coastal waters: (see Chapter 5)

- Land claim- High impact
- Land claim- Low impact
- Dredging- High Impact
- Dredging- Low impact
- Other disturbances to seabed
- Sea disposal of dredgings
- Structure to manipulate flow/sediment
- Structures with piled supports
- Shoreline reinforcement- High impact
- Shoreline reinforcement- Low impact
- Flood defence embankment
- Tidal channel realignment- High impact
- Tidal channel realignment- Low impact
- Impounding structures
- Causeways

Methodology

Sources that have been consulted to identify potential future pressures on estuaries and coasts include National and County Development Plans and the DCENR and DAFF in relation to applications for Dumping at Sea Licenses and energy generation and foreshore licences/leases. Also consulted were the Marine Institute, including the Irish Maritime Development Office (IMDO), along with a number of project and interest group websites and reports.

8.2 Drivers / Sectors

The drivers / sectors that are considered most likely to contribute to morphological pressures in transitional and coastal water bodies are listed below:

- Coastal Defence
- Flood Management
- Infrastructure, including oil, gas and cables
- Navigation
- Agriculture
- Fisheries and Aquaculture*****
- Mining, quarrying and mineral extraction
- Recreation
- Water Abstraction for industrial use

Specific issues such as sea level rise are discussed at appropriate points.

***** Detailed assessment of aquaculture or fisheries is not within the scope of this study. However, for the purpose of the risk assessments aquaculture was reviewed as a component of the morphological pressure 'other disturbances to seabed' (estimated areas dredged for shellfish). The potential future trend of the aquaculture industry is briefly addressed in this chapter as it can potential be associated with significant supporting coastal infrastructure as well as dredging activities.

8.2.1 Coastal Defence and Flood Management

The development of coastal defence puts in place flow and sediment modification structures, impoundments and/or shoreline alteration and embankments in order to protect human populations, property and important environmental assets and from the sea.

Ireland has a high proportion of its population located in coastal areas, where the majority of major towns and cities are situated. County Development Plans of Irish coastal counties suggest that there may be increased development in coastal areas.

Whilst only around 25% of Irelands population live in Coastal Electoral Districts, most of Irelands urban centres are coastal, and a much larger percentage are dependant on these areas (Sweeney et al, 2003). The Sustainable Rural Housing Guidelines for Planning Authorities (DEHLG, 2005) acknowledges the likely increased demands for coastal development and the requirements for management for both housing and tourism industries (holiday homes and facilities). It was estimated that there could have been increases up to 50% in coastal populations around Ireland between 1991 and 2001 (EEA, 2006) exceeding most other European areas.

Together with consideration of sea-level rise, this could potentially result in the need for more widespread or raised coastal defences. Such developments can alter the morphology of estuaries and make the ecology susceptible to 'coastal squeeze' or the compression and change of shoreline succession in biotopes or removal of intertidal areas. Existing (increasingly stringent) legislation related to land use planning and development in flood risk areas should limit such pressures relating to coastal defence development, particularly with the increasing commitment to Integrated Coastal Zone Management (ICZM). There may be some new impacts related to the implementation of 'soft' flood management and erosion protection techniques such as managed realignment schemes. Another 'soft' protection option is the reuse of suitable materials from dredging or foreshore development for beach nourishment.

Based on the data provided by Marine Institute (Shoreline erosion risk data, received 2007), 1562 km of Ireland's 10837 km coastline is at risk of erosion (though 3827 km has no data available). A small proportion currently falls under areas of population requiring coastal defence. Around 4% of Ireland's coastline is currently protected (as opposed to over 80% in the UK and Netherlands). However, pressure from development and population growth may increase the amount of defence required in the future, as will changes in sea level.

The new Floods Directive (2007/60/EC) on the Assessment and Management of Flood Risks entered into force on 26 November 2007. This Directive now requires Member States to assess if all watercourses and coastlines are at risk from flooding, to map the flood extent and assets and people at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. The identification of potential areas of risk, may result in the development of further flood protection. However, whether this is co-ordinated on a national basis or at a strategic or local level is as yet unclear.

8.2.2 Sea-level rise

One of the major unknown factors for pressures on marine areas is the question of sea-level rise and possible increase in storm surge activity which could further raise sea levels in extreme conditions. This may lead to impacts including wave damage on soft shores, increased seasonal flooding and inundation of low-lying areas, interference with coastal developments and infrastructure, and the disruption of coastal habitats (changes in near-shore salinities, sediment loading and distribution due to alterations in river discharges). The IPPC (Intergovernmental Panel on Climate Change) highlights the uncertainties in assessing average global sea level rise, but have recorded that global sea level has risen approximately 175mm on average between 1961-1990 and the rate is increasing. Sea-level rise increased in the decade 1993–2003 to 3.1 mm/year compared to the average of 1.8 mm/year for the years 1961–2003. The main reason is because water expands as temperature rises, though losses from ice sheets in Greenland and Antarctica are very likely to have contributed in recent years (IPCC, 2007).

The UK 'Foresight' report on Flood and Coastal Defence (GoS, 2004) aimed to produce a challenging and long-term (30 - 100 years) vision for the future of flood and coastal defence for the UK that takes account of such uncertainties. The report identified the drivers and receptors of future trends in flooding, and assessed the likely environmental and socioeconomic impacts. For Northern Ireland, the report predicts rises in relative sea level (between 20 cm and 69 cm) and greater storm surge intensities in the Irish Sea causing a risk of significant flooding in the east of Ireland.

Secular mean sea level rise for the tidal gauge station in Dublin is at a rate of 0.23mm per year (POL, 2000). Sweeney et al, (2003) provides a best estimate of future sea level rise for Ireland, from a number of sea level rise models, of 0.48m from 1990 to 2100. The report suggests that up to 300 km^2 of land could be inundated by the sea if sea level rose by 48 cm by the end of the century. The report particularily highlights the potential impacts on urbanised areas, where flood and sea defences are most likely to be constructed to mitigate against flooding, due to the economic value of these areas.

Eurosion (2002) states the "worst case" scenario, global mean sea-level is expected to rise 95 cm by the year 2100, with large local differences due to tides, wind and atmospheric pressure patterns, changes in ocean circulation, vertical movements of continents etc. The Eurosion report (2002) also references the IPCC, a series of flood risk studies which are currently being undertaken in Ireland, in accordance with the new Floods Directive (2007/60/EC) to assess the potential flood risk areas within RBDs. This is being undertaken by local authorties and the Coastal Engineering Division (OPW, DAFF and DCENR).

Sea level rise is only one potential change to sea defence requirements. Climate change also causes increases in average wave height and storm surges. In Ireland, the Wave and Storm in the Northern Atlantic group (WASA, 1998) has recorded an increase rate of 0.3% per year of average west coastal wave height. Storminess is more difficult to quantify, though the IPPC (IPPC, 2001) have determined that in general increases in storminess has been within natural variability, Storm occurrence in Ireland is also linked to large scale circularion changes (Sweeney et al, 2000), which have tripled in the last decade and associated with North Atlantic low pressure systems, which have seen a similar increase. Small scale changes of wave height and storm events may result in over-topping of exisiting or natural protection causing saltwater intrusion into terrestrial and freshwater areas, as well as damage coastal infrastructure. In areas where existing measures are damaged or saltwater intrusion occurs, these coastal measures may then require repair, extension or redevelopment.

Increased sea levels and wave heights are likely to mean an increase in requirements for foreshore stregthening and coastal defence including sea walls and impoundments. Proposals for tidal barrages could also increase if sea levels rise. An existing proposal for such a development is that outlined by Clonakilty Urban District

Council for the development of a rock armoured tidal barrage across Clonakilty Bay proposed to reduce tidal flooding and assist freshwater flood prevention. Dublin and Cork have had various schemes suggested in the press in 2007, but no schemes or plans have been offically submitted.

8.2.3 Infrastructure

A range of infrastructure developments may cause pressures on marine morphology. The demands on coastal development are already increasing dramatically as it provides the location or natural resources vital to energy, communications, and transportation in competition with increasing demand for housing in coastal locations along with the infrastructure associated with housing development. In Ireland the most significant expected alterations are from ports and oil and gas facilities. Modifying the coastal structure, maintaining channels for shipping and reclaiming land for facilities can extensively modify a water body. Ireland as an island is socio-economically reliant on ports for the import and export of materials, supplies and commodities.

Ports

The most significant coastal infrastructure is likely to be port development (see also navigation below), which by their nature must be located on estuaries or coasts. Coastal locations for port developments are limited, requiring appropriate access on a range of tides, and a sufficiently sheltered location to allow vessels to be loaded and unloaded as efficiently and safely as possible. Ports are a vital transport link for the Ireland; it is estimated that up to 90% of Dublin City's resources are transported via the port. In smaller estuaries and within smaller ports, the opportunities for new port capacity are very limited. The growth in some sectors such as containerised traffic and roll-on roll-off, combined with changes in traffic patterns, means that ports continue to propose substantial new developments to increase capacity. These require additional land, reclamation of estuaries and the deepening of approach channels. In addition, the increase in containerisation has increased the efficiency of much of the transportation industry, but requires large storage facilities within ports to process the containers.

Shipping operators are pivotal in dictating the direction the industry takes in terms of infrastructure investment; by commissioning bigger vessels (particularly container ships), pressure is placed upon port operators to provide suitable infrastructure or lose trade to competitors. Ports wishing to retain trade have to expand, provide deeper access channels, bigger berths and more shore-side cargo handling and storage capacity (MI, IMDO, DEHLG, 2007). Typical developments which may be part of a port expansion that may impact on marine morphology include quaylines, berths, breakwaters, land/foreshore claim, dredging, and causeways.

Ports are seen as an important contributor to the Irish economy and a source of growth, and many County Development Plans (for example Kerry, Wexford, Wicklow, Louth, Galway, Clare, Limerick and Waterford) (DEHLG, 2007) support the further development of ports by improving infrastructure, safeguarding lands against inappropriate development and making provision to establish new ports (NDP, 2006). Many ports have recently submitted expansion proposals, a summary of each is given below (DoT, 2006)

- **Greenore Port:** Proposal for a 300m quay, part of the terminal to be reclaimed from the sea and associated dredging.
- **Drogheda/Bremore Port:** New terminal - proposal for a 500m quay, berthing facilities, 2.3km breakwater, 58ha reclamation.
- **Dublin Port:** 2 x 360m quays, 21ha foreshore reclamation.
- **Rosslare:** Dredging, quay extension and reconstruction.
- **Waterford:** 300m new quay.
- **Cork:** New container terminal, 480m quay, land claim.
- **Shannon-Foynes:** 700m quay (plus another potential 600m), 35.5ha land claim.

In addition to the port itself there are associated industries within or adjacent to the ports that require development, land claim and foreshore protection. Perhaps the most significant is the onshore facilities associated with the oil and gas industries, such as the proposed LNG facility in the Shannon, currently being designed, or the associated receiving and gas power stations that have been proposed for receiving gas and electricity generation from the Corrib Gas field.

Oil, Gas, Pipelines and Cables

Ireland has a small number of existing pipelines, servicing the oil and gas infrastructure at Seven Heads and Kinsale with another currently being developed at Corrib. Between 1997 and 2000 only 10 exploration and appraisal wells were drilled in Irish waters but no commercial discoveries were made - in total only 187 have been drilled in Irish waters. Eight exploratory licences were issued in 1995 in the Porcupine Licensing Round but these have been relinquished. Of the eleven exploratory licences issued in 1997 in the Rockall Licensing Round, 10 have been relinquished.

The Petroleum Affairs Division of the DCENR has released two further offshore areas for exploration in the last two years (DCENR/ former Department of Communications Marine and Natural Resources (DCMNR), Ministerial announcements 2007/8). The first resulted in five applications from four companies for Frontier Exploration Licences in the Frontier Sylne/Erris/Donegal Licensing Round. IOSEA1 (Irish Offshore Strategic Environmental Assessment 1) and IOSEA2 and the upcoming IOSEA3 by the Petroleum Affairs Division provide further information on Ireland's exploratory oil and gas work.

Though uptake on the Irish markets is low, due to the more extreme conditions and depth of drilling operations required, there has been increasing interest in the resources under the European Western Margin. As resources decrease elsewhere, the Irish Energy Policy has prioritised security of supply for Ireland from localised oil and gas exploration, meaning that this activity is set to increase and the associated infrastructure (pipelines, well rigs, support vessels etc) will also increase. Finds from the current and recent licensing rounds will require infrastructure should any be developed into production phases.

Cables are a vital conduit for telecommunications and power transfer between Ireland, its coast and islands, and with its neighbours. Ireland is also adjacent to much of the transatlantic cables from the US into Europe. The rights of development and laying of cables is protected under UNCLOS (United Nations Convention on Law of the Sea, 1984 (in force 1994)). In addition to the existing cables around Ireland there are proposals for more telecommunication cables to the UK and US. Also power cables have been proposed from Dublin and Belfast to the UK and Scotland for electricity trading. The proposed renewable energy industries, discussed in the next section, will also need power connectors and sub-sea cables with coastal grid connectors.

EirGrid plc, the company responsible for operating Ireland's national electricity grid have submitted a foreshore licence to carry out surveys of the seabed conditions in the vicinity of Rush Bay in north Dublin. The purpose of the marine survey is to assist in the selection of a preferred route for an interconnector linking two separate transmission systems.

There are a number of short and long sea outfalls around Ireland, most notably two for Dublin (Dollymount) and two in Cork (Carrigrennan and Tranmore) and one in Galway (Mutton Island). The use of these for treated sewage disposal may increase as a result of measures arising from the WFD as highlighted in the Significant Water Management Issues reports. The Groundwater and Municipal and Industrial Programmes of Measures study for the WFD will have more information on these issues as the treatment of effluent and its' discharge is considered in detail in these studies. Other types of infrastructure development may include Waste Water Treatment Plants near the coast or on estuaries to service increasing populations.

Renewable Energy

Major Foreshore Licences have been granted by DCENR for offshore wind farms at Arklow and at Codling Bank (DCENR, 2007). The impending construction of these may have a range of impacts (although these should be identified and mitigated through the requirement for Environmental Impact Statements). Codling Wind Park on Codling bank has been granted a major foreshore licence agreement for its development as a lease, dated 15/11/2005, under Section 2 of the Foreshore Acts to construct and operate a wind farm at Codling Bank off the coast of County Wicklow for a term of 99 years. A number of areas have been designated for offshore wind farm development on the east and west coast. They are released and leased in a similar way to oil and gas production blocks with a licence from the DCENR.

The Marine Institute, who are actively promoting research into wave and tide energy, consider that Ireland's offshore renewable energy resources (offshore wind, wave and tide), are among the best in the world. Based on available wind and wave conditions, several areas have been identified for future development by the Marine Institute (DCENR, 2007 and Marine Institute data incorporated into the Marine Morphology Other Pressures, see Chapter 3). In addition, Ireland recently announced a 33 per cent renewable energy target for 2020 and specifically mentioned marine renewables (DCENR, Press release, 11 February 2008). The Marine Institute have developed a technology hub in Galway Bay where new technologies can be trialled, such as the WaveBob design that was demonstrated in 2006 (Marine Institute and DCMNR press release 21 March 2006).

8.2.4 Navigation

Navigation is closely linked to pressures associated with port development. The most significant impacts on marine morphology (particularly bed sediments) is the removal of material by dredging, either to maintain, deepen or create navigation channels and, to a lesser extent, maintaining berths. Maintenance dredging in ports and harbours is likely to be ongoing, and the impacts are generally considered to be low and short-lived if good practice is followed. Capital dredging to deepen or create new channels will be less widespread and will usually be linked closely with port development issues discussed above. There are also links to recreational navigation which is discussed below.

The disposal of dredged material/spoil is another significant pressure. Disposal sites identified as located within WFD TraC water body boundaries are recorded in the GIS pressure shapefiles. Table 8.2 below outlines the most recent ‘Dumping at Sea’ licences authorised by DAFF (the former DCMNR).

Table 8.1: Summary of Dumping at Sea Licences, obtained from DAFF (former DCMNR) website (2007)

Permit Holder	Permit No.	Date of Issue	Period of Validity	Description	Quantity (tonnes)
Drogheda Port	Amended Permit No. 345	08/02/07	15/1/07 – 31/12/07	Dredge Spoil	9,000 tonnes daily to a max of 312,400 tonnes
Drogheda Port	Amended Permit No.378	15/01/07	15/01/07 – 28/02/07	Dredge Spoil	10,000 tonnes daily to a max of 250,000
Port of Cork	Amended Permit No. 354	23/02/07	19/01/07 – 31/12/07	Dredge Spoil	20,000 tonnes daily to a max of 1,650,000
Shannon Foynes	Amended Permit No. 365	23/02/07	17/02/07 – 31/12/08	Dredge Spoil	30,000 daily to a max 750,0000
Port Oriel, Co. Louth	380	14/02/07	9/02/07 -28/02/07	Dredge Spoil	4,500 tonnes
Port Oriel, Co. Louth	Amended 380	23/02/07	28/02/07 – 21/03/07	Dredge Spoil	4,500 tonnes
Drogheda Port	381	28/03/07	27/03/07 – 28/04/07	Dredge Spoil	10,000 tonnes
Drogheda Port	382	06/07/07	03/07/07 --31/07/07	Dredge Spoil	10,0000 tonnes
Galway County Council Inishbofin	383	13/07/07	12/07/07 – 31/10/07	Dredge Spoil	1,000 daily up to 54,000 tonnes (including any material dumped since 2005)
Dublin City Council	384	10/0707	24/10/07 – 30/11/07	Dredge Spoil	2,500 tonnes
Port of Waterford	Amended Permit No. 360	16/11/07	16/11/07 – 29/02/08	Dredge Spoil	Up to a max of 2,193,000 tonnes (inclusive of material dumped since 23/01/04)
Dublin Port	Permit No. 388	18/12/07	18/12/07 – 17/12/08	Dredge Spoil	80,000 tonnes daily to a max of 800,000 tonnes

8.2.5 Recreation

Recreational use of TraC waters has recently been promoted by the Marine Institute through its ‘Development Strategy for Marine Leisure Infrastructure’ (MI, 2005) which focuses on developing leisure-related infrastructure around water-based tourism clusters. This type of infrastructure may include marinas, pontoons, moorings, slipways, piers, breakwaters, and dredging operations, with similar impacts, albeit on a smaller spatial scale, to those caused by infrastructure and navigation.

The ‘Development Strategy for Marine Leisure Infrastructure’ (MI, 2005) suggests a limited number of new facilities, predominantly along the west coast of Ireland, with enhancement and upgrade of existing facilities in most other areas (for example at Wexford, Helvick and Ballycotton. In Cork, the need for a large development in the Baltimore/Schull area was identified (DEHLG, 2007), with the suggestion that Castletownbere harbour is strategically well located and would benefit from the development of leisure boat facilities. On the west coast, Kilronan is identified as a potentially strategic site for development, whilst the Galway area was identified as justifying a marina. Clifden, Westport, Killala, Sligo and Donegal might justify smaller scale developments. North Mayo is underdeveloped at present for marine leisure and careful consideration needs to be given to the siting of a major development. In Donegal, the fishing ports of Killybegs and Burtonport have been proposed as strategically important sites and marina developments are planned for Rathmullen and Buncrana (MI, 2005).

8.2.6 Agriculture

Agriculture tends to be a less significant risk to morphology of coastal areas than to freshwater habitats. However there are some low-impact activities that occur in coastal areas, particularly on saltmarsh habitats. A search of the Ramsar database showed that overgrazing and drainage are considered to be ‘threats’ to the ecological integrity of some estuarine and coastal wetlands around Ireland. Grazing of saltmarsh is a traditional management practice, but if the numbers of livestock increase significantly the overgrazing impacts may become more intense and/or widespread.

NPWS have proposed measures to limit overgrazing of coastal wetlands, especially Annex 1 habitats such as saltmarsh and bogs within protected areas, and there are financial incentives under the REPS scheme to protect these areas from overgrazing. The results of a saltmarsh distribution study will be produced in mid 2008 (NPWS).

Intensive coastal agriculture has not yet been mapped with sufficient confidence to make assessments of future trends. For the Marine Morphology PoMS study the output of the Corrine survey was used to identify areas of agricultural land and urbanised areas to use as an indicator of areas of intensive land use.

The REPS (Rural Environment Protection Scheme) does recognise coastal grazing pressure and encourages non intensive use but does not differentiate habitat types.

8.2.7 Mining, Quarrying and Mineral Extraction

There is currently limited extraction of marine aggregates almost exclusively for marine area infilling for land reclamation. However, with a decline in the availability of viable onshore alternatives, significant research is being undertaken to acquire baseline data to inform strategies for potential increase in such activities. One of the outputs of the INFOMAR project (GSI, 2007) is to identify potential future resources. The INFOMAR programme has identified a number of priority bays and three coastal areas to map in detail (see Figure 4.3 of Chapter 4) As well as providing information for other uses, the outputs will be assessed for potential marine aggregates. The current Irish Sea Marine Aggregates Initiative (IMAGIN) (INTERREG, 2006) aims to develop a strategic framework for exploitation of marine aggregate resources in the Irish Sea, with minimal risk of environmental impacts or risks to other marine users and have currently identified a number of possible areas for exploitation to the east of Ireland (INTERREG, 2006). Such activities are likely to be further offshore but could be considered to pose a potential future pressure (and also potentially increase shipping traffic/dock developments).

Much of Ireland's ability to extract marine sands and gravels has been limited by the investment that would be required to find suitable resources (Interreg, 2001). However, the INFOMAR and INSS (Irish national Seabed Survey) will provide the information to identify the extent and potential of these resources, which may lead to future demands for extraction, especially as land based resources are under increasing pressure. By way of an indication of the potential importance of this resource, in the UK marine aggregates supply 21% of sand and gravels requirements in England (and 90% of Wales' sand requirements) (Gubbay, 2006)

In addition, Ireland has previously granted small scale license for maerl extraction and several areas have been identified as under pressure for industry development (e.g. Blackhead Bay Co, Clare Heritage Council Landscape reports, 2006, Lonehort Point, Bear Island, Co. Cork, MI, 2005). However, it is considered that Lonehort is the currently the only existing licence.

8.2.8 Water Abstraction

The information collated as part of the marine morphology task has shown there are few licences for marine abstraction in Ireland, with the exception of some small scale coastal water abstractions in the Shannon associated with gas infrastructure. Water from marine and coastal waters is predominantly extracted for cooling water for industrial processes and power generation. The most likely trend in marine abstraction is an increase due to the oil and gas industries and associated power generation.

Liquid Natural Gas (LNG) has been identified for development in Ireland in order to assist in the security of gas supply networks (DCENR, 2007). LNG is natural gas that has been cooled to a very low temperature (minus 160 degrees centigrade), at which point it becomes a liquid. Liquefying natural gas reduces the volume it occupies by more than 600 times, making it manageable for storage and transportation. Current developments include the facility in Shannon, which will comprise of 600 acres of coastline and a dredged channel to receive LNG tankers from export sources include Algeria, Australia, Egypt, Indonesia, Malaysia, Nigeria, Oman, Qatar and Trinidad. The facility includes abstractions of cooling waters from the estuary as part of the degasification process. The natural gas is then piped onto the grid and is expected to be operational by 2011 (Minister for Enterprise, Trade and Employment press release 22 May 2006).

In addition, gas powered electric generating stations have been proposed in combination with the Corrib development and LNG facilities in the west of Ireland. The DCENR outlines the development of coastal power stations and the conversion or upgrade of existing facilities, such as those in Cork and Dublin, to generate electricity from natural gas (DCENR, 2007). Such facilities will require cooling waters and therefore are likely to need abstractions from coastal resources in order to operate.

Along the east coast of Ireland the potential long term implications of water demand and shortfalls are being examined. Dublin in particular has identified a significant water shortage by 2012. The Dublin Water Feasibility SEA (DCC, 2006) identifies a desalination option with estimated flow capacity of between 9,090 m^3/h (Phase 1) and 13,636 m^3/h (Phase 2). If approved this would be a significant marine abstraction and is provisionally planned in North Fingal.

8.3 Conclusions

The River Basin Management Plans will set out proposals for waterbodies on a six year cycle. As a result there is a requirement to assess the drivers and sectors likely to affect marine morphology and specifically the pressures on eco-morphological factors over the future, which may in turn affect the ecological status of transitional and coastal waters.

The main overarching trends likely to affect marine morphology are climate change and associated sea level rise, and the effect these have on coastal areas, causing increased flooding and the need for coastal protection, affecting the morphology and 'squeezing' the ecology. The sea level rise is likely to be exacerbated by an increase in storm surges causing flooding resulting in a need for greater coastal flood defenses.

The uncertainties of climate change make it difficult to predict with any accuracy the coastal protection that might be associated with sea level rise / increase in storm surges and possible freshwater shortages that could affect Ireland in the future.

Additional pressures, that are linked to climate change, are the possibility of water demands exceeding supply in some areas, resulting in the need for water abstraction and potentially desalination, to meet requirements. The possibility of these water shortages can change agricultural patterns to put more pressure on coastal areas, and increase the need for expansion of fisheries and aquaculture industries to meet growing demands.

Pressure from ports and coastal population centres are also likely to develop in coastal areas and estuaries. {At present Ireland has concentrated coastal communities with low levels of population in the majority of regions, such that overall the pressure on the coastal zone is currently limited to a low percentage of Ireland's coastline in comparison to its European neighbours (EEA, 2006) However, Ireland is reliant on sea transport for much of its trade. All major Irish ports are likely to expand in the near future and there are plans to increase and distribute national capacity by the addition of new facilities. Ports often expand by land claim or need shoreline reinforcements and flow modification structures to operate. Ports also require safe navigation, meaning dredging of channels and berths, and the dumping of this material at sea.

Marine energy generation is also likely to increase in the near future. Oil and Gas exploration licencing is currently being rolled out in Ireland with the National Energy Policy highlighting the need for safeguarding Ireland energy supplies. Also within the energy policy are drivers to increase the amount of renewable energy production, and marine technologies (wind, wave and current) are most likely to increase in the near future. The expansion of these industries will also result in increased requirements for subsea pipelines and cables.

Fisheries and aquaculture are a significant industry in Ireland with plans to expand, though these industries have a low impact on morphology they can have a cumulative effect and the associated support infrastructure on the coastal zone can affect the marine morphology. Coastal and marine recreation are also important sectors which there is a likelyhood of increase, meaning more coastal structures and facilites, such as accomadation and marinas.

Finally, there have been programmes undertaken to assess the offshore agregates available to Ireland. As terrestrial sources become scarcer or more expensive, there is a possibility that marine aggregate industries may wish to develop in Ireland.

Ireland is likely to see an increase on demand for coastal resources in the future, which in tern will mean an increase in coastal pressures and could affect marine morphology if not properly managed.

9 Recommendations for the Design of the Monitoring Programme

9.1 Introduction

As outlined in Chapter 4 Ireland has in place a series of monitoring programmes in the marine environment, assessing various factors relating to sediments, water quality, chemistry and fish/shellfish quality. The WFD proposes to combine these programmes into a strategic sampling programme. This monitoring programme has been scoped, proposed and costed by the Marine Institute and EPA, but has yet to provide specific assessment of hydromorphology.

Overall there are two requirements for marine morphological data - to provide monitoring for the classification of water body status, and, to detect changes that may affect this status. To achieve this, a morphological baseline for TraC water bodies is needed to determine the existing condition of a water body, and then the relationship between pressures and their impact on morphology (and subsequently ecology) needs to be refined so that changes can be efficiently monitored.

A baseline of morphology should include sediment type, bathymetric profile, and flow conditions. From a review of existing and planned monitoring programmes (Chapter 4) it is proposed to adapt and record morphological monitoring surrogates to firstly input to the assessment of current conditions then to assist in the monitoring of changes until such time as a national inshore morphological baseline is available.

Morphological monitoring should ideally be collected within existing monitoring programmes including that proposed for coastal waters within the WFD monitoring programme. This is not only the most efficient method, but also enables morphological data to be associated with other information such as ecological data which may assist in the interpretation of changes and the potential reasons for these changes.

9.2 Recommendations for baseline conditions and change

9.2.1 Baseline Conditions (existing status)

The reporting of baseline conditions requires the physical survey of Ireland's TraC water bodies to provide a fixed reference from which changes can be assessed. At present this does not exist for Ireland. Therefore, surrogate information (such as historical timeline information of physical parameters recorded from previous monitoring programmes, site specific assessments for the purpose of EIAs, foreshore licence applications, etc.) can indicate existing status as well as long term changes where no fixed reference conditions are available. However, as noted previously; morphology changes can be triggered by natural changes in TraC waters and this should be considered in all interpretations of monitoring results.

A central repository for such information would prove beneficial to the collation and use of national morphological data. This is discussed furthering Section 9.2.4.

The INFOMAR project is of particular relevance in supplying baseline morphological information for many TraC water bodies.

In the absence of adequate baseline data to provide evidence-based reference conditions, the presence or absence of pressures on morphology, as identified by this study, may be used as indicators of morphological status class. The SNIFFER study titled 'Development of Hydromorphological Reference Conditions and Draft Classification Scheme for Transitional and Coastal Waters', discussed in Section 5.4.2 of Chapter 5, based many of the classification 'metrics' on the extent or presence / absence of a pressure. For example; Metric 2, 'changes in sediment budget and composition', has the following assessment threshold: '***length of frontage influenced by reinforcement or beach management / total length of frontage'***. Although this SNIFFER study was not progressed, the UK Environment Agency in association with the UK and Ireland Marine Task Team have undertaken extensive research for these metrics. It is therefore recommended that in the absence of formal monitoring systems to refine impact assessment methods such as TraC-MImAS, 'metrics' such as those outlined by SNIFFER may be used to report on high status water bodies.

Chapter 6 identified those water bodies for which no, or minimal, pressures are currently present. On completion of the national PoMS studies and the formal classification of biological and physico-chemical quality elements, those water bodies not considered at risk from achieving high ecological status due to other factors can be confirmed. The further assessment of these water bodies as a priority to address any information restrictions experienced by this study (e.g. restricted orthophoto coverage) can confirm the presence or absence of pressures impacting on morphology. TraC water bodies not impacted by other factors and not influenced by physical alterations [upstream or adjacent] may be considered as demonstrating high ecological status in the absence of monitoring. However, it is important to ensure legacy issues are considered, particularly if the biological classification tools applied do not relate to morphology.

In the absence of formally adopted classification tools defining the parameters and standards / conditions required, it is difficult to recommend specific monitoring requirements. However, using the framework of TraC-MImAS, possible morphological indicators can be recommended for inclusion in future monitoring programmes (baseline and assessment of changes). Module 1 of TraC-MImAS considers a series of ecologically relevant features and process, and as noted in Chapter 5, each of these attributes was chosen "***for its role in the direct or indirect support of ecological communities and the supporting processes needed to create and maintain the physical environment on which ecological communities depend***" (SEPA, 2007 version a4).

The first RBMPs will identify those water bodies provisionally classified as high status. It is recommended that monitoring of baseline morphological conditions is undertaken at these sites to provide reference conditions which can be considered for monitoring in relation to surveillance and operational programmes. These reference conditions are likely to be specific to each water body. However, further definition of the water body typologies via baseline monitoring may facilitate type-specific reference conditions. In addition to refining the typologies as a whole, this study has identified a requirement for the site specific assessment of various water bodies for which the existing typology may not be consistent with actual conditions (see Chapter 6).The completion of such monitoring will contribute to the requirements of the WFD in relation to classification.

Table 9.1 below outlines the potential sources of baseline information and future monitoring data that can be used to report on and monitor these eco-geomorphic attributes. Potential additional monitoring and other practices which may be applied to supplement existing and proposed monitoring systems for these purposes are also suggested where possible.

Table 9.1: Eco-geomorphologic attributes and potential monitoring parameters, including likely ecological monitoring indicators

Eco-geomorphic Attributes	Definition	Monitoring	Frequency / Coverage	Ecological monitoring / survey	Additional monitoring / practices
		Potential existing and future sources of monitoring parameters	Frequency and spatial extent of existing/proposed systems	Associated ecological observations from ecological / biometric monitoring	Recommendations for the collection of baseline (status) date and assessment of change
All eco-geomorphic attributes		**Additional monitoring / practices:** ***Centralised repository for data collected by existing and future systems (including EIA, Foreshore applications and conservation monitoring).***			
Hydrodynamics	**Describes the influence of the tides, waves and freshwater inflow**				
Tidal range	***The height that the sea rises and falls over a tidal cycle***	Marine Institute Tidal network observations Ports tidal gauge information	Regular interval or continual monitoring. Limited coverage, only a few offshore observations and ports (HMWB)	Changes in habitat distribution, especially intertidal most notably strandline location Possible changes to biotopes with greater /less exposure tolerance.	Increase tidal gauge network to represent TraC water bodies. May need to be supplemented from other studies including EIA, Foreshore licence applications etc where available
Currents	***Currents associated with the rise and fall of the tide***	Current metering. Marine Institute Tidal network observations Current monitoring (EISs', Foreshore / dumping at sea licences) Granulometry/ depth recordings	Regular interval or continual monitoring. Limited coverage, only a few offshore observations and ports (HMWB) Some additional data available from other studies but limited availability Surveys and monitoring (EISs, Foreshore / dumping at sea licences) usually once-off survey events. SAC monitoring – 3 year cycle for Site Inspection Reporting, and 7 year reporting cycle for Favourable Conservation Status	Changes in ecology to biotopes associated with more / less exposed conditions. Changes in sediment type	Increase tidal gauge network to represent TraC water bodies. Co-ordination with INFOMAR programme and SAC baseline surveys into central repository to build seabed sediment maps and bathymetric data store for Ireland.
Freshwater flow	***Riverine input into TraC Waters, maybe modified by human interference of catchment hydrology/land use changes***	CDT (Conductivity, depth and temperature readings) Intertidal salinity measurements (optic)	EPA existing CDT monitoring programme, and basic measurements from other programmes, monitoring programme. Frequency may change under WFD. Single record / intermittent	Changes / localized opportunistic euryhaline algal growth / bloom. Increase in species with FW tolerance.	Co-ordinate with hydrometrics and other PoMS studies; expand assessments to TraC water bodies.
Flushing/exchange	***The length of time it takes for a transitional water or sea loch to exchange its water***	Flow readings (Hydrometrics)	Some flow meters in CFB and EPA networks. Regular measurements through hydrometrics programmes, underway and planned.	Possible changes to biotopes with greater /less exposure tolerance.	Co-ordinate with hydrometrics and other PoMS studies; expand assessments to TraC water bodies.
Salinity / mixing / stratification	***Occurs in transitional waters and sea lochs where freshwater input is important***	CDT (Conductivity, depth and temperature readings) Intertidal salinity measurements (optic)	EPA existing CDT monitoring programme, and basic measurements from other programmes, variable frequency Optic measurements from EIA / Foreshore applications – usually single temporal record	Possible changes to biotopes with greater /less freshwater tolerance.	Salinity measurements within a number of the proposed WFD monitoring programmes need to be centrally collated from all programmes.
Waves	***Waves are important in driving sediment transport processes***	No specific monitoring planned. MI localized monitoring and planned SmartBay prototype. Ports tidal gauge information, Some wave estimation models have been carried out for wave energy development.	National wave model could be developed under Sea Change programme to identify resources for wave energy. Likely to be at coarse scale model. Estimation models and field surveys to support flood evaluations.	Possible changes to biotopes with greater /less exposure tolerance.	Link to flood monitoring and Floods Directive programmes which will evaluate wave height for coastal inundation and defence Collation of studies undertaken for specific developments

Table 9.1 (continued): Eco-geomorphologic attributes and potential monitoring parameters, including likely ecological monitoring indicators.

Eco-geomorphic Attributes	Definition	Monitoring	Frequency / Coverage	Ecological monitoring / survey	Additional monitoring / practices
		Potential existing and future sources of monitoring parameters	**Frequency and spatial extent of existing/proposed systems**	**Associated ecological observations from ecological / biometric monitoring**	**Recommendations for the collection of baseline (status) date and assessment of change**
Intertidal Zone	**Describes the size and structure of the intertidal zone**				
Geometry	Describes the spatial extent and form of the intertidal zone				
Planform	***Aerial view showing planar area of the intertidal zone (2D perspective). Describes the outline and spatial extent, or area of the intertidal zone which can change in response to prevailing coastal processes and/or realignment of the high water mark due to engineering activities.***	Bathymetry, shoreline profile, especially multibeam swathe (INFOMAR) Shallow water LiDAR Ortho photography	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes Shallow water LiDAR, national coverage to be carried out. Can be repeated in areas of suspected change (erosion / deposition); 3 or 6 yrs suggested Frequency of orthophotography are as per the OSi coastal mapping requirements. Variable frequency dependant on changes.	Possible changes to biotopes with greater /less exposure tolerance. Possible changes to biotopes with greater /less freshwater tolerance. Changes in habitat distribution, habitat loss.	Co-ordinate morphological survey with existing programmes. SAC monitoring transects and other intertidal survey programmes. National repository for bathymetric data collected from other programmes (Foreshore / EIA) Co-ordinate with OSi for orthophotographic records to compare and LiDAR / Digital Elevation Model data.
Profile	***Cross sectional form of an estuarine channel or gradient of the shoreline.***	Bathymetry, shoreline profile, especially multibeam	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Possible changes to biotopes with greater / less exposure tolerance. Possible changes to biotopes with greater / less freshwater tolerance. Changes in habitat distribution, habitat loss.	Co-ordinate morphological survey with existing programmes. SAC monitoring transects and other intertidal survey programmes. National repository for shore profile data collected from other programmes (Foreshore / EIA)
Morphological features and substrate	Describes the shape and character of geomorphological features, and the size, structure and sorting of the intertidal sediments				
Nature and extent of coastal features	***Topography and geomorphological and vegetation features of the coastal zone e.g. saltmarsh, seagrass, sand dunes, mudflats, sand bars, spits.***	NPWS SAC monitoring and habitat mapping. Coastal LiDAR Orthophotography	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Possible changes to biotopes with greater /less exposure tolerance. Possible changes to biotopes with greater /less freshwater tolerance. Changes in habitat distribution, habitat loss.	Co-ordinate morphological survey with existing programmes. SAC monitoring transects and other intertidal survey programmes. Ground truthing surveys of coastal orthophotography and LiDAR to identify and record features
Natural sediment size range	***Is the sediment size distribution natural***	Granulometry samples (benthic sampling)	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Changes in habitat distribution. Habitat loss, change of biotope to altered substrate.	Co-ordinate morphological survey with existing programmes. SAC monitoring transects and other intertidal survey programmes. Add parameter to propose WFD marine monitoring programme and those active transitional WFD subnets. Ground truthing surveys of coastal orthophotography and LiDAR to identify and record features Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.

Table 9.1 (continued): Eco-geomorphologic attributes and potential monitoring parameters, including likely ecological monitoring indicators.

Eco-geomorphic Attributes	Definition	Monitoring	Frequency / Coverage	Ecological monitoring / survey	Additional monitoring / practices
		Potential existing and future sources of monitoring parameters	Frequency and spatial extent of existing/proposed systems	Associated ecological observations from ecological / biometric monitoring	Recommendations for the collection of baseline (status) date and assessment of change
Continuity and sediment supply	Assesses interruptions to coastal processes and sediment supply				
Longitudinal sediment transport processes	***Describes sediment mobilisation pathways i.e. transport of material by littoral drift from adjacent water bodies.***	Current metering, turbidity / suspended solids Flood risk studies, EUROSION network Localised changes in sediment type, profile or bathymetry	Currently infrequent.	Changes in habitat distribution. Habitat loss, change of biotope to altered substrate.	Data from flood risk studies should be co-ordinated with other surveys to provide data. Coastal process modelling should be carried out when sufficient data is collected Co-ordinate morphological survey with existing programmes. SAC monitoring transects and other intertidal survey programmes. (coastal erosion) Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.
Lateral sediment transport processes	***Includes land to sea connectivity and describes inputs and outputs of sediment from erosion of cliffs, catchment derived input from fluvial sources and material transported from offshore.***	Current metering, turbidity / suspended solids Flood risk studies, EUROSION network Habitat loss, change of biotope to altered substrate.	Currently infrequent.	Changes in habitat distribution. Habitat loss, change of biotope to altered substrate.	Data from flood risk studies should be co-ordinated with other surveys to provide data. Coastal process modelling should be carried out when sufficient data is collected Co-ordinate morphological survey with existing programmes. SAC monitoring transects and other intertidal survey programmes (coastal erosion) Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.
Sub tidal Zone	**Describes the size and structure of the subtidal zone**				
Geometry	Describes the spatial pattern and form of the subtidal zone				
Planform	***Aerial view showing planar area of the subtidal zone (2D perspective). Describes the outline and spatial extent, or area of the subtidal zone which can change in response to prevailing coastal processes and/or engineering activities.***	Bathymetry, shoreline profile, especially multibeam (INFOMAR) Shallow water LiDAR, ortho photography.	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Possible changes to biotopes with greater /less exposure tolerance. Possible changes to biotopes with greater /less freshwater tolerance. Changes in habitat distribution, Habitat loss	Co-ordination with INFOMAR programme and SAC baseline surveys into central repository to build Seabed sediment maps and bathymetric data store for Ireland
Profile	***Cross sectional form of a channel or of the coastal zone perpendicular to the coastline***	Bathymetry, shoreline profile, especially multibeam	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Possible changes to biotopes with greater /less exposure tolerance. Possible changes to biotopes with greater /less freshwater tolerance. Changes in habitat distribution, Habitat loss	Co-ordination with INFOMAR programme and SAC baseline surveys into central repository to build Seabed sediment maps and bathymetric data store for Ireland Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.

Table 9.1 (continued): Eco-geomorphologic attributes and potential monitoring parameters, including likely ecological monitoring indicators.

Eco-geomorphic Attributes	Definition	Monitoring	Frequency / Coverage	Ecological monitoring / survey	Additional monitoring / practices
		Potential existing and future sources of monitoring parameters	**Frequency and spatial extent of existing/proposed systems**	**Associated ecological observations from ecological / biometric monitoring**	**Recommendations for the collection of baseline (status) date and assessment of change**
Morphological features and substrate	Describes the shape and character of geomorphological features, and the size, structure and sorting of the intertidal sediments				
Nature and extent of bed features	***Topography or specific features of the seabed e.g. sand banks, ripples.***	Bathymetry, shoreline profile, especially multibeam / ADGS or video transects. Shoreline profile / Shallow water LiDAR	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Possible changes to biotopes with greater /less exposure tolerance. Possible changes to biotopes with greater /less freshwater tolerance. Changes in habitat distribution, Habitat loss	Centralised repository for data collected by other studies (EIA, Foreshore licence application, SAC monitoring s etc) Co-ordination with INFOMAR programme and SAC baseline surveys into central repository to build Seabed sediment maps and bathymetric data store for Ireland Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.
Natural sediment size range	***Is the sediment size distribution natural***	Granulometry samples (benthic sampling)	Baseline required for RoI waters. Frequency of repetition is not set, however, surveys are most cost effective if included with existing programmes	Habitat loss, change of biotope to altered substrate.	Co-ordination with INFOMAR programme and SAC baseline surveys into central repository to build Seabed sediment maps and bathymetric data store for Ireland Add parameter to propose WFD marine monitoring programme and those active transitional WFD subnets. Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.
Continuity and sediment supply	Assesses interruptions to coastal processes and sediment supply				
Longitudinal sediment transport processes	***Describes sediment mobilisation pathways i.e. transport of material by littoral drift from adjacent water bodies.***	Shoreline profile / Shallow water LiDAR Granulometry samples (benthic sampling)	Currently infrequent.	Changes in habitat distribution. Habitat loss, change of biotope to altered substrate.	Data from flood risk studies should be co-ordinated with other surveys to provide data. Coastal process modelling should be carried out when sufficient data is collected Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.
Lateral sediment transport processes	***Includes land to sea connectivity and describes inputs and outputs of sediment from erosion of cliffs, catchment derived input from fluvial sources and material transported from offshore.***	Shoreline profile / Shallow water LiDAR Granulometry samples (benthic sampling)	Currently infrequent.	Changes in habitat distribution. Habitat loss, change of biotope to altered substrate.	Data from flood risk studies should be co-ordinated with other surveys to provide data. Coastal process modelling should be carried out when sufficient data is collected Supplement field observations with Particle Size Analysis (PSA) to ensure consistency.

9.2.2 Monitoring of morphological changes

Morphological conditions are very site specific and subject to natural fluctuations. It is therefore considered that extensive research, that extends beyond the existing WFD monitoring system, is required before a national morphological monitoring programme can be established to adequately assess changes in ecologically relevant features and processes. Monitoring of specific morphological attributes has been limited to date; therefore, monitoring trials may be required to provide confidence in monitoring practices defined to indicate changes influenced by anthropogenic modifications.

From the review of monitoring outlined in Chapter 4, recordings from proposed and active monitoring and survey programmes in Ireland have been assessed. The parameters used have been evaluated against their potential use as morphological indicators.

TraC-MImAS provides a suitable framework to assist in the regulation of future physical alterations. The modular structure of this framework enables the further development of specific aspects of the tool. Investigative monitoring is essential to refine the modules in this tool so as to increase confidence in its use as a decision support tool.

Until such time as an adequate national baseline is available, the information collected for morphology as part of existing programmes or proposed monitoring may be used to indicate potential changes in morphology (changes to eco-geomorphic attributes) that may affect water body status.

Using the existing and proposed monitoring programmes detailed in Chapter 4 a number of recommendations are suggested to help ensure morphology is adequately surveyed under the WFD requirements.

9.2.3 Intertidal

Special Areas of Conservation (SAC) are currently monitored for conservation status using a series of transects that have been established to assess the biological quality of the SAC and in particular their features of interest. As a set transect, this provides an opportunity to monitor the morphology of the intertidal area whilst providing additional information that can be used to interpret the biological data*****. Also, the physiotope data currently collected by this monitoring system can provide some time series data to inform morphological baseline / reference conditions.

Consideration could be give to an alternative method of collecting additional intertidal morphological information by levelling the transects used to monitor SACs. At present there are samples taken from habitat transition points along the transect, and a GPS location is taken. By survey levelling of these sites, changes in morphology can be assessed. This information, coupled with the granulometric**** and biological data can be used as an indicator of morphological changes, and allow better interpretation of biological changes along the transect. Such changes of monitoring systems however would require additional time and resources.

For some SAC sites, diver transects may be carried out as part of the monitoring and can be treated in a similar way with digital depth gauge readings at sample sites to level the transect together with ecological and substrate observations. This information is likely to be limited in accuracy, however it would provide some baseline data and indications of gross morphological changes until suitable baseline data is available (potentially via the INFOMAR programme).

9.2.4 Subtidal, Coastal and Transitional

Registers of marine models and Environmental Impact Statements (EISs) completed in Ireland were generated as part of the Literature Review (Appendices 2-1 and 3-2 respectively). The studies identified are potential sources of baseline information regarding specific issues that may arise from future developments or site specific requirements.

***** However, after discussion with NPWS (telecom Dr E Kelly, 04/02/2008) it seems NPWS may be changing the intertidal SAC monitoring to a stratified random transect programme in the near future which suggests that direct comparison of results and assessment of local changes in morphology and assessments attributing changes in ecology may be restricted. Levelling data on the stratified random transects within SACs could still assist the classification of a water body's morphology and provide information on baseline conditions from which changes can be assessed. However, due to the length of some areas of the foreshore collection of such data within the existing programmes may not be practical or cost effective.

****** granulometry can be attributed to sediment type and depth

Activities with significant potential morphological impact are required to provide baseline data on the bathymetric profile and sediment types, pre and post the activity being undertaken. For example, in the case of dredging, analysis of the sediments to be removed is carried out prior to the dredging activity. In most cases this is accompanied by bathymetric survey maps, the quality of which can vary significantly. The results are submitted with the application to the appropriate regulator. Similar studies are required for the laying of cables and pipelines and other marine activities, especially for the oil and gas industries.

A national database of such models, surveys and analyses would be of significant benefit to compilation of a national register of baseline TraC morphological conditions. The structure of the NS-Share Monitoring Database, discussed in Section 4.3.1 of Chapter 4, may provide a suitable framework to develop this.

Also, the submission of electronic, and where possible geo-referenced, copies of survey results and reports from dredging, dumping at sea and coastal development applications could be collated a central repository to allow the data to be assessed and compared with ongoing work, and also in providing a national baseline through the INSS and INFOMAR programmes.

As outlined previously in Chapter 4, the INFOMAR programme, a hydrographic mapping programme of select areas around the coast, may be interpreted to provide a national inshore morphological baseline. This can be supported by ecological surveys by the NPWS and Marine Institute to allow evaluation of ecological status and eco-morphological assessments.

The shallow water LiDAR surveys being carried out for the flood management and National Flood monitoring programme could be repeated in areas of concern to examine possible changes in morphology and provide valuable baseline data in the subtidal areas.

Another potential combining of marine morphology monitoring and other programmes could be to carry out bathymetric / Acoustic Ground Discrimination system (AGDS) monitoring during benthic and plantonic surveys. This has been suggested in a draft proposal made by the Marine Institute (MI (Draft), 2006). If adopted, this would provide interim baseline transect (plankton surveys) and point records (benthic surveys) that can be used as an indicator to monitor changes in marine morphology. Such a programme would require additional time and potentially extensive resources. However this system of monitoring would not only provide baseline information (until national datasets can be compiled), but also provide time series repeat transects that can be assessed for changes. Such a system could be prioritised for those water bodies indicating no or little risk to high ecological status to provide reference conditions.

Finally a programme of investigative monitoring to establish the coastal process pathways (erosion, deposition, coastal currents) should be instigated in the future, building on the data being collected from existing programs such as EUROSION European erosion studies, and Catchment Flood Risk Assessment and Management Study (CFRAMS) flood risk mapping. Such information can assist with management and determination of morphological processes and the effects of marine morphological pressures upon water bodies.

9.3 Recommendations for information requirements

To help refine and / or clarify some the assumptions made throughout this study regarding the relationship between pressures and impacts on morphology (and subsequently ecology) it is recommended that the framework of SEPA's TraC-MImAS tool is used as a basis for future assessment.

TraC-MImAS assesses the impact of pressures differently for the intertidal and subtidal zones. A national dataset depicting these zones is unavailable. To support the use of TraC-MImAS and also refine the general relationship between pressures, and morphological conditions to assist future monitoring, detailed scale maps are required. Detailed maps of high and low water marks will have significant benefit to the assessment of coastal changes (erosion and deposition etc).

Module 1 – Eco-geomorphic attributes

Table 9.1 outlines the eco-geomorphic attributes considered in TraC-MImAS and recommends monitoring systems to collect information relevant to these. These attributes were determined by professional judgement in the absence of field-based data.

Monitoring can help refine, or in some cases discount, this professional judgement by providing scientific data to confirm the relevance of these attributes to morphology of TraC waters. Suggestions as to how this may be undertaken are outlined in Table 9.1. However, it is difficult to define exact parameters and methods in the absence of previous monitoring for many of these attributes.

The TraC-MImAS tool does not require data to be entered for these attributes, but assumes their relevance to six TraC water body 'types'. There is potential for the association of certain eco-geomorphic attributes with water body types, to be refined as the monitoring of TraC waters progresses.

Module 2 - Typology

It is a recommendation of this study (and the Marine Morphology Steering Group) that on completion of sufficient TraC monitoring programmes, Irish TraC water bodies are reviewed and re-typed where required. In addition to refining 'type-specific' reference conditions, this will help increase confidence in the use of TraC-MImAS, the results of which are largely dictated by the water body 'type' being assessed. As noted in Section 5.2.2 in Chapter 5, the eighteen TraC water body types defined within Ireland and the UK for the WFD were grouped into six overall water body types for the development and application of TraC-MImAS. The typology of TraC water bodies was defined using 'System B' as specified in Annex II of the WFD, and therefore meets the requirements of the WFD. However, TraC-MImAS can be refined by using both ecological and morphological baseline conditions to further type water bodies. For example, it may be possible to divide a water body into various sub-types to reflect the appropriate baseline conditions to allow for increased sensitivity values to be applied to certain water bodies such as those supporting large saltmarsh habitats. At present the typology module does not support the assessment of specific Protected Areas. Detailed monitoring of such areas will improve the framework for future assessment of change.

In addition to refining the assumptions of TraC-MImAS, the WFD requires that type-specific hydromorphological conditions are established to represent the quality elements. However, Annex II (1.3)(iii) allows for type-specific conditions to be established using expert judgement where other methods are not possible.

In establishing type-specific reference conditions, the WFD allows the exclusion of a quality element from the assessment of ecological status if it is not possible to establish reliable type-specific reference conditions '***due to high degrees of natural variability in that element***' (Annex II (1.3)(vi)). In such circumstances Member States must state the reasons for this exclusion in the RBMPs.

Module 3 – Morphological and Ecological Sensitivity

The morphological component of this module is based on the likelihood that an attribute of the particular water body type being assessed will change in response to a pressure. To estimate ecological sensitivity (relating to all WFD biological elements) the likelihood that a disturbance to individual attributes (via pressures) will result in a degradation of community or species integrity is estimated and quantified. The sensitivity of both these elements is again based on professional judgement.

As noted in Chapter 4, only three of the TraC biological classification tools can be related to morphological conditions (macroalgae, saltmarsh and seagrass). The completion of these studies in addition to existing monitoring undertaken by the NPWS can help refine the sensitivity values used in TraC-MImAS for the purpose of supporting regulation. With regard to classification of morphological conditions, the relationship between the attributes and biological elements will require focused investigation. The monitoring of eco-geomorphic attributes at sites identified for the application of these biological classification tools should help identify the existing conditions relative to the biology present. Historic biological monitoring results available for such a site can then be reviewed to determine any relationship between biology and the introduction of physical alterations.

The establishment of a nationally consistent monitoring programme for morphological change is not considered possible or efficient at this stage. Due to the current lack of scientific evidence of the relationship between morphology and ecology, focused investigative monitoring is recommended so as to adequately inform national monitoring programmes for both classification and impact assessment purposes.

Recommendations for the collation of national baseline data have been made. Prior to this, baseline conditions can be monitored at those water bodies identified as having little or no physical alterations. If monitoring is undertaken in association with the relevant biological classification tools, an adequate reference condition for that water body type may be determined. If confidence is established in the typology of a water body then similar monitoring can be undertaken in a water body of the same 'type' which is subject to physical alterations.

The difficulty with this process is that attributes such as planform and natural sediment size range require site specific historic data to determine the reference condition for a particular water body. Therefore, although the typology of two water bodies may be comparable using the parameters defined by the WFD there specific morphological attributes may vary significantly. As noted previously to resolve this difficulty, the presence or absence of anthropogenic physical alterations may be considered as an appropriate reference condition. Qualitative values can then be used to determine changes in morphological condition, the thresholds for which can be informed by investigative monitoring, but are likely to always require some expert judgement.

Module 4 – Impact Assessment

The assessments within this module are independent of water body type. The module forms a distinction between the intensity and extent of impacts by estimating the likelihood that a morphological alteration will have an impact on an eco-geomorphic attribute, and quantifies whether impacts are likely to be contained within the vicinity of the pressure, or be pervasive. The ‘zone of impact’ is considered an important aspect of monitoring for morphological impacts/changes. The assessment of direct loss of habitat associated with physical alterations is a simple process. However, the nature of TraC waters may restrict the definition of ‘zones of impact’ i.e. natural fluctuations in conditions can significantly alter how the effects of a pressure are received by the environment.

Again, the values contained with TraC-MImAS were determined using professional judgement. Therefore investigative monitoring, and research, are required to increase confidence in these values. As noted in Chapter 6, water body trials were undertaken across Ireland and Scotland. However, with the exception of initial trials undertaken by SEPA during the development of TraC-MImAS, these trials did not include field assessments.

Module 5 – Cumulative Impact Assessment

In the absence of environmental standards for morphological elements, Morphological Condition Limits were defined, and trialled, for use in TraC-MImAS (see Section 5.2.5 of Chapter 5). The results of the trials indicated good correlation between the MCLs and professional judgement of ecological status. Also, the results of the further characterisation process (Chapter 6) are considered consistent with general existing conditions for many water bodies. Those water bodies for which the results have been questioned (highlighted in red italics in Appendix 6-3) are for the most part associated with the lack of data to adequately consider the pressures on a water bodies. In addition to data gaps identified by Chapter 3, a significant gap in the assessment of morphological pressures is that relating to aquaculture (and fishing) practices. It is recommended that morphological monitoring specific to the 'worked' areas is undertaken to refine the results of the further characterisation process.

Further development of the MCLs, in the absence of formal classification, will require field assessments including investigative monitoring to refine the association of these values with morphological and ecological status class.

9.4 Conclusions

A WFD marine monitoring programme has been identified and proposed to meet the requirements of the Directive. The monitoring programme, does not specifically address morphology. However, information can be collected and assessed within existing systems to allow further water body characterisation and measurement of changes.

In the absence of formally adopted classification tools defining the parameters and standards / conditions required for morphology, it is difficult to recommend specific monitoring requirements.

It is essential for the monitoring of marine morphology, that a reliable baseline against which to make assessments and assess future development proposals is collected. There are a number of programmes already underway, (the most notable being INFOMAR), that can provide this information. However, they will not be complete until towards the end of this first River Basin Management Plan cycle.

As a result, it is proposed that records from a number of national survey and monitoring programmes are used to assess potential marine morphological changes until such time as this baseline is available. To improve the efficiency of such a process, it is recommended that a central repository of available data is compiled for use by the relevant authorities. It is proposed later in this report (Chapter 11) that future development applications are accompanied by GIS-based data to enable development of a national centre for such assessment data. Applications could provide drawings and location maps in GIS or georeferenced Autocad drawings to support establishment of an electronic archive of coastal developments relevant to marine morphology.

The WFD should ensure that monitoring undertaken for the purpose of such applications considers the quality elements specified by the WFD. This data, collated in a central repository can help inform future assessments and establish a national baseline. Formal guidance at Government level would facilitate this process (this is discussed further in Chapter 11).

Once this baseline is available it will be possible to investigate morphological changes that have caused ecological deterioration.

It is recommended that in the absence of formal monitoring systems to refine impact assessment methods such as TraC-MImAS, 'metrics' such as those outlined by SNIFFER (2007) may be used to report on high status water bodies, i.e. for use in the classification and reporting of high water body status to the European Commission.

It is considered that further investigation and refinement of the components of TraC-MImAS will help form a more efficient monitoring system. There is currently a lack of field-based scientific knowledge relating to the assessment of TraC morphology and further research is required before a national monitoring system can be established and applied with confidence.

Further field trials, monitoring results, and professional judgement throughout Ireland will all benefit the refinement of TraC-MImAS as a whole. However, due to the nature of estuarine and coastal water bodies, TraC-MImAS, or any similar tool developed, has limited capabilities for the assessment of site specific conditions. Therefore, further development should be focused at refining this tool for its continued use in **supporting** regulation.

10 RECOMMENDATIONS FOR THE DESIGN OF THE PROGRAMMES OF MEASURES

10.1 Introduction to the Requirements for a Programme of Measures 3
10.1.1 Basic Measures 6
10.1.2 Supplementary Measures 8
10.2 Existing Legal Framework Relevant to Morphology in TraC Waters..........9
10.2.1 Responsible Bodies Governing Irish TraC Waters 9
10.2.2 Legislative Structure Governing Irish TraC Waters 10
10.2.2.1 Governing Legislation – International.......................................10
10.2.2.2 Governing Legislation – European..11
10.2.2.3 Governing Legislation – National, Regional and Local Levels..20
10.2.2.4 Guidance..27
10.2.3 Conclusions from Legislative Appraisal (Basic Measures) 29
10.3 Recommendations for Basic Measures and Supplementary Measures ..31
10.4 Prioritisation of TraC Water Bodies for the Application of Appropriate Measures...33
10.4.1 Introduction 33
10.4.2 Prioritisation of TraC Water Bodies 40
10.4.3 Identification of Appropriate Measures 50
10.5 Overall Conclusions 63

The objectives of this chapter are to:

- Recommend how Ireland's TraC water bodies may be prioritised for the application of appropriate morphological measures with the aim of achieving WFD objectives by 2015; and
- Recommend how appropriate morphology measures can be identified to achieve these objectives; together with achievement (restoration) and protection (preservation) of good and high morphological (and therefore ecological) status.

In meeting these objectives, the information outlined in this chapter, read in conjunction with Chapters 7 (Good Practice) and 11 (Recommended Regulatory Decision Support), is used to develop appropriate recommendations for the design of morphology related PoMs.

Firstly, the WFD requirements for PoMs are outlined. Then, following a review of relevant legislation, a method for the prioritisation of TraC water bodies suitable for the assessment of appropriate measures is recommended. Using information available at the time of writing, this method was applied to Irish TraC water bodies and the potential objectives for all 309 water bodies are assessed.

With regard to the preservation of status, Chapter 11 leads on from this chapter to define how the deliverables of this study can supplement the existing framework for the future mitigation and regulation of physical alterations.

The recommendations made in this chapter are generic and are not outlined specifically for each prioritised water body.

Appendix 11-1 tabulates a summary of proposed measures identified as relevant for marine morphology within the template required for reporting to the National PoMS Co-ordination Group.

10.1 Introduction to the Requirements for a Programme of Measures

The WFD River Basin planning cycle comprises four key elements:

1. Characterisation and assessment of impacts on River Basin Districts.
2. Environmental monitoring.
3. Setting environmental objectives.
4. Design and implementation of programmes of measures required to achieve the objectives.

The characterisation and assessment of impacts regarding Ireland's TraC water bodies is addressed via the initial and further characterisation process, as outlined in Chapters 1, 3 (Data Review), and 6 (Further Characterisation) of this report. On completion of all PoMS studies, national data will be compiled and used to assess RBD specific water management issues.

Existing and proposed monitoring relating to morphology is discussed in Chapters 4 and 9 of this report. On completion of appropriate monitoring (and PoMS studies), results will be collated to inform the setting of default environmental objectives, i.e. by classifying water body status. All water bodies will then have a quality status class which will require improvement or maintenance in accordance with Article 4 of the WFD (responsibility of the Local Authorities).

The WFD requires the setting of objectives for all water bodies, compliance with standards and objectives set for protected areas i.e. designated nature conservation sites, shellfish waters, bathing areas etc, and the implementation of cost effective programmes of measures to meet those objectives. The Directive recognises that under specific circumstances it may not be realistic to set 2015 as the deadline for achieving 'good status' for all water bodies by allowing (strictly conditional) derogations where alternative objectives can be set. Decisions about the use of alternative objectives must be based on the factors set out in Article 4 of the WFD, including consideration of the technical feasibility and of costs and benefits of implementing the measures which would be necessary to achieve the WFD objectives in a given water body.

Article 11 of the WFD sets out the requirements for the establishment of PoMs in order to achieve the objectives set out in Article 4. Of relevance to marine morphology, Member States are required to implement the necessary measures to:

- prevent deterioration of the status of all bodies of water (Article 4(1)(a)(i));
- then protect, enhance and restore all bodies of surface water with the aim of achieving good surface water status by 2015 (Article 4(1)(a)(ii)); and
- comply with the standards and objectives for Protected Areas (Article 4(1)(c)).

To prevent deterioration in the existing status of waters, the risks to priority waters should be assessed to determine their likely status by 2015 (taking into account the effectiveness of full compliance with existing directives). Section 10.5 of this chapter recommends how TraC water bodies can be prioritised for consideration of PoMs, and using the information available at the time of writing, this method was applied to all 309 TraC water bodies. Tables 10.1 and 10.2 in this chapter identify those TraC water bodies considered to be of priority for the application of measures by listing the predicted default objectives. The results of TraC-MImAS are expressed as status class boundaries, however, it is important to clarify that the use of these 'status' terms in further characterisation indicates **risk** to status class only, and does not represent classification results (e.g. a result indicating 'Good' should be interpreted as have no risk to the achievement of good ecological status). The potential risks to existing [risk] status can be determined following assessment of the pressure layers generated by this study and the results of TraC-MImAS. Appropriate PoMs to prevent deterioration of status can then be identified.

With regard to the restoration of water bodies to at least Good Ecological Status (GES), there may be some circumstances where it is technically infeasible or disproportionately expensive within the first River Basin Management cycle. Where it can be demonstrated that restoration is not possible (technically infeasible or disproportionately costly) mitigation measures should be investigated with the aim of meeting Good Ecological ***Potential*** (GEP).

In consideration of protected areas, DEHLG have advised that when the ***'EPA classifies a surface water body associated with a protected area, failure of the water body to achieve the water related objectives of the protected area will result in the surface water***

body being classified as less than good regardless of whether other objectives are met' (DEHLG, December 2007). Article 4(2) of the WFD requires that where more than one of the objectives of Article 4(1) (including that for protected areas) relate to a water body, the most stringent shall apply.

Article 11(2) of the WFD requires that the PoMs, to be presented in summary form in the RBMP, "shall include the 'basic' measures" and, "where necessary, 'supplementary' measures".

On completion of the national PoMS studies, appropriate technical options for proposed measures can be combined with economic studies to determine the most appropriate and cost effective PoMs for each River Basin District. PoMs will be set out in the draft RBMP in December 2008 for public consultation, then confirmed in the first RBMP in December 2009, and should be implemented by June 2012. PoMs should aim to achieve the required objectives by 2015 at the end of the first River Basin Management cycle, and be revised where necessary for the next cycle.

Throughout this Chapter, the term 'measure' can refer to both the physical actions required to achieve objectives e.g. Good Practice measures (as outlined in Chapter 7), as well as the mechanisms required to recommend and / or enforce these actions e.g. formal guidance, statutory consultation, and/or legislation. The 'physical actions' should consist primarily of ***supplementary measures*** whereas mechanisms can be addressed by either ***supplementary*** or new ***basic measures***. Both basic and supplementary measures are discussed later in this section.

The definitions of 'measures' provided in Chapter 7, and outlined below, refer to the physical actions required on the ground (supplementary measures):

- General good environmental practice and management plans; such as the implementation and maintenance of sectoral Environmental Management Systems and monitoring programmes e.g. by port companies.
- Mitigation measures; such as the planning of the timing, frequency and extent of dredging activities.
- Restoration measures; such as the recreation of intertidal mudflats lost through land claim or coastal protection and defence structures.

- Natural recovery - although unlikely to contribute significantly to the first RBMP, natural recovery can be the most cost-effective and sustainable approach to achieving WFD objectives.

For the purpose of this study, the mechanisms required to implement measures can be defined as the existing and future decision and evaluation processes in place to assess physical modifications with the aim of protecting morphology [and ecology]. New basic measures for the control of physical modifications may be required in addition to these mechanisms, and supplementary measures, such as the improvement of guidance, can enhance the ability of these mechanisms to protect, restore and improve status. With regard to the future regulation and protection of status, Chapter 11 of this report should be referred to as it outlines how the deliverables of this study. The TraC-MImAS tool, can enhance and support the existing framework for future physical modifications to Ireland's transitional and coastal waters.

10.1.1 Basic Measures

Basic measures are the minimum requirements to comply with (Article 11(3)) and include existing EU legislation and controls on major pressures. The role of basic measures is to ensure legal compliance and implementation of existing European Directives, outlined in Annex VI (Part A) of the WFD. Ireland has implemented Basic Measures by adopting the EU Directives listed and has integrated the relevant water legislation under the implementation of the Water Framework Directive (S.I. No. 722 of 2003).

Those directives to be included in the PoMs, as prescribed in Annex VI, are outlined below with those of particular relevance to morphology emphasised in bold italics:

- The Bathing Water Directive (76/160/EEC)
- ***The Birds Directive (79/409/EEC)*** (relating to the protection of habitats of importance to protected birds)
- The Drinking Water Directive (80/778/EEC)
- The Major Accidents (Seveso) Directive (96/82/EEC)
- ***The Environmental Impact Assessment Directive (85/337/EEC)***

- The Sewage Sludge Directive (86/278/EEC)
- The Urban Waste-Water Treatment Directive (91/271/EEC)
- The Plant Protection Directive (91/414/EEC)
- The Nitrates Directive (91/676/EEC)
- ***The Habitats Directive (92/43/EEC)***
- The Integrated Pollution Control Directive (96/61/EC)

In addition to those directives listed in Annex VI, it is anticipated that pending relevant European Directives ratified since the WFD will also be implemented under the basic measures (Article 12 (3), S.I. No. 722 of 2003). Those of particular concern to marine morphology are considered in Section 10.2 below, and include:

- The Floods Directive (2007/60/EC)
- The Environmental Liability Directive (2004/3/EC)
- The Marine Strategy Directive (draft) (Resolution 9388/2/2007)

A summary of the corresponding national and local legislation is provided in Section 10.2.2.3.

In addition to the above, and of relevance to morphology, the WFD also allows for the implementation of new basic measures relating to controls on abstraction and impoundment of freshwater (Article 11(3)(e), and measures to ***'ensure that the hydromorphological conditions of the bodies of water are consistent with the achievement of the required ecological status'*** (Article 11(3)(i).

DEHLG (December 2007) require an assessment of the effectiveness of new basic measures in meeting the objectives to be undertaken, and note that any gaps in meeting the required objectives should be identified and addressed through supplementary measures directed at the pressures causing the failure. The potential for new basic measures relating to morphology is introduced in Section 10.2.2 of this chapter and, as noted previously, recommendations relating to the future regulation of pressures are detailed in Chapter 11. Supplementary measures, defined below, were introduced and detailed in the Good Practice Review in Chapter 7. Recommendations for appropriate supplementary measures to support basic measures are outlined throughout Section 10.2 with relevant conclusions in Section 10.4.

10.1.2 Supplementary Measures

Where it is concluded that the full application of the basic measures is not adequate to meet the objectives of the WFD, supplementary measures can be considered. Supplementary measures can enhance basic actions to achieve water objectives, and may include optional measures such as legislative, administrative or economic instruments, negotiated environmental agreements, codes of good practice, recreation and restoration of wetland areas, efficiency / reuse measures and education and partnership projects (Annex VI Part B). In relation to morphological conditions; supplementary measures should include site specific intervention such as actions to remediate or mitigate for particular physical modifications or developments.

10.2 Existing Legal Framework Relevant to Morphology in TraC Waters

This section summarises the existing legislative framework, i.e. the existing mechanisms, which is of relevance to morphology and governs the development and use of Irish TraC waters, at International, European, National, Regional, Local and at project level.

The applicability of the existing legislation facilitating compliance with WFD objectives is then assessed in relation to morphology, and, where relevant, recommendations for how morphology may be considered more appropriately within this framework are made, primarily through the use of new basic measures and supplementary measures.

Supplementary measures recommended in this section relate to the enhancement of these mechanisms. Chapter 7 should be referred to for a comprehensive review of appropriate good practice for supplementary measures aimed at the restoration of morphological conditions and mitigation of morphological pressures.

Recommendations specific to the regulation of future coastal developments and activities are discussed further in Chapter 11. To assist the reader in considering the benefits of these recommendations, Chapter 11 also provides an example of how they can support the existing regulatory framework in the assessment of a proposed harbour development within a water body of High Ecological Status (HES).

The following broad review of existing measures governing the morphology of Irish TraC waters is not intended to be a comprehensive nor detailed analysis of TraC legislative frameworks. A full detailed assessment of the effectiveness of marine legislation should be carried out at such time as the revision of the existing regulatory frameworks is undertaken.

10.2.1 Responsible Bodies Governing Irish TraC Waters

As noted previously, following the general elections held in May 2007, various responsibilities relating to coastal waters were transferred between government departments. This resulted in the formation of the new Department of Agriculture, Fisheries and Food (formerly the Department of Agriculture and Food, transferred under S.I No. 705/2007) to which certain functions of the former Department of Communications, Marine and Natural Resources (DCMNR) under the Foreshore Acts (1933 – 1998) have been transferred. The DCMNR has now changed to the Department of Communications, Energy and Natural Resources (S.I No 706/2007). Therefore, coastal developments in Ireland are currently governed by the Department of Environment, Heritage and Local Government (DEHLG); local authorities; the Department of Agriculture, Fisheries and Food (DAFF); and the Department of Communications, Energy and Natural Resources (DCENR).

To ensure the appropriate consideration of morphology (and the WFD as a whole) for Irish TraC waters, **confirmation of the structure and functions of all responsible bodies is of foremost importance**.

10.2.2 Legislative Structure Governing Irish TraC Waters

A detailed review of the interrelation and integration of national, EU and international water related policies and laws is beyond the scope of this study. However, this section aims to identify those that will potentially be of most significance to morphology and the implementation of and compliance with the WFD.

On a national basis, the objectives of the WFD can only be achieved if plans and programmes in other relevant policy areas are coordinated and integrated. Such plans and programmes should include Habitat and Species Protection Plans (conservation management plans) under the Habitats Directive, strategic National Development Plans and related Local Plans, and Flood Management Plans.

The RBMPs are subject to Strategic Environmental Assessment (SEA) which will help ensure that the wider environmental considerations are integrated into these plans.

10.2.2.1 Governing Legislation – International

The WFD requires that basic measures should include those required to implement Community legislation (Article 11(3)(a). However, it is important to note that specific sectors, such as the ports and navigation sector can be substantially governed by various international laws and policies in addition to Community legislation, consideration of which may be appropriate when proposing measures.

In relation to the protection of ecology supported by morphological conditions, the RAMSAR Convention on Wetlands of International Importance helps promote the wise and sustainable use of wetland resources. This Convention came into force for Ireland in March 1985 and lists wetlands of good quality which are characteristic of their region. In Ireland all RAMSAR sites (47 No.) are legally protected as Special Areas of Conservation (SACs) and / or Special Protection Areas (SPAs) and / or National Heritage Areas (NHAs) and may be managed under Conservation Management Plans (see Section 10.2.2.2).

This EU and national protection of RAMSAR sites provides Ireland with appropriate tools for the assessment and management of these sites.

10.2.2.2 Governing Legislation – European

The following outlines the relevant EU Directives required to be implemented under the Water Framework Directive, as well as those implemented since the WFD as well as pending directives. For each directive an assessment is made of the relevance to morphology and where it may be possible to introduce additional measures.

<u>Current European Directives</u>

The Strategic Environmental Assessment (SEA) Directive (2001/42/EC)

The SEA Directive ensures that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. SEA also ensures that the public and other relevant bodies have an opportunity to participate in the planning process (in accordance with the Public Participation Directive (2003/35/EC)), including neighbour Member States, and their own public, in the case of likely trans-boundary significant effects. The SEA Directive also includes requirements for environmental reporting, broad-scale assessment of cumulative effects, and requirements of monitoring and appropriate assessment.

The River Basin Management Plans, including proposed PoMs, fall under the SEA Directive, and an assessment of the Proposed Plans and Programmes (PPP) is being undertaken within Ireland. The screening and scoping stages of the SEA for the RBMPs were complete at the time of writing of this report, and suggested objectives have been selected.

The SEA process allows for the cumulative assessment of potential impacts; however, at present it is considered that there is a gap in the existing national legislation (and guidance) for the appropriate assessment of cumulative issues in Ireland.

SEA and Marine Morphology

SEAs are required to assess the significant environmental impacts and interactions of a PPP. The WFD ensures that morphology is considered in the RBMPs, and the SEA Directive ensures that the PPP of the RBMPs are assessed; therefore it is considered that morphology will be adequately considered at this high level. However, this may be restricted due to a lack of awareness and a formal method of assessment for morphology.

As detailed later in Chapter 11, the Marine Morphology study can provide significant input to the development of a formal morphological assessment measure. With regard to awareness of morphological related issues, the WFD requirements for public participation and the involvement of this study in public meetings and sector specific workshops, are considered to have adequately promoted morphology in the relevant sectors. However, as noted previously, the structure and function of governing bodies responsible for Ireland's TraC waters is key to the success of such a strategic assessment.

The results of this study will inform the RBMPs which can then potentially be utilised at this level to assist decision making.

In general terms, the adoption of the findings of the study, including recommendations for monitoring and further development of assessment tools, should significantly contribute to the cumulative and strategic assessment of proposed plans to help ensure that the morphological capacity limit of water bodies can be assessed, monitored and managed.

Environmental Impact Assessment Directive (85/337/EEC as amended by 97/11/EC and 2003/35/EC)

The EIA Directive of the effects of projects on the environment is incorporated into Irish law by the 1989 EIA Regulations. The Directive specifies which projects require an Environmental Impact Statement (EIS) in Annexes I and II of the Directive. Mandatory thresholds are provided for Annex I projects only. However, in transposing Annex II Ireland specified thresholds for these projects within the regulations.

The EIA procedure should ensure that environmental consequences of projects are identified and assessed before authorisation is given.

Many large scale coastal developments require an EIS to be prepared, providing an opportunity for morphological impact to be considered within this framework. For those developments which fall below the specified thresholds, Irish planning legislation provides for the consideration of significant environmental effects and potential direction for the preparation of an EIS (triggered by sites of conservation sensitivity and / or planning appeals).

The requirements for the content of an EIS are outlined in the legislation and in 2002 the EPA published guidance on the information to be contained in an EIS. Also, in 2003, DEHLG published guidance on EIA for consent authorities regarding sub-threshold developments.

EIA and Marine Morphology

As with the SEA, the EIS is required to consider any significant environmental effects of proposed developments and activities. To ensure compliance with the WFD, this should now include an assessment of morphology. At present morphology is not specifically required to be examined within the EIA framework, although a review of Irish EISs (Appendix 3-2 and Section 3.2.1.6 of Chapter 3) has confirmed that morphological conditions are considered in many shoreline developments where an impact is expected. However, assessment can range from desk-based reviews to extensive estuarine or coastal modelling, and is dependant on the issues identified by the scoping stage and / or consultation.

Recommendations for new basic and supplementary measures associated with the existing EIA process are detailed in Chapter 11. The new basic measures consist of additions to the existing EIA regulations to help trigger the consideration of morphology where relevant for sub-threshold development (refer to Section 11.2.2). Recommendations for supplementary measures are made by outlining how the deliverables of the Marine Morphology study can be used to enhance the EIA process in Ireland, specifically at the screening, scoping and consultation stages. Section 11.3 provides a specific example of how the assessment of morphology can be improved within the existing regulatory mechanisms to facilitate compliance with the WFD.

The Birds & Habitats Directives (79/409/EEC and 92/43/EEC)

The Birds and Habitats Directives require Member States to provide for the preservation, protection and improvement of the quality of important, rare, and threatened natural habitats and specific species of plants, birds and animals, as a contribution to the general objective of sustainable development. In Ireland existing measures include consideration of the protected sites in local and regional land use plans (e.g. county development plans), special assessments of the impacts of certain activities on the conservation status of designated habitat types and species within the site (via the EIA process.)

The objective of the Habitats Directive is to conserve natural habitats and wild fauna and flora in the EU. To attain this, the directive requires the establishment of a network of SACs. The Birds Directive requires the protection of all wild birds and their habitats, and to realise this, the directive requires SPAs to be designated for wetlands which attract large numbers of migratory birds as well as the listed bird species. These sites of Community importance are known collectively as the Natura 2000 network.

The Habitats Directive was transposed into Irish law through the European Communities (Natural Habitats) Regulations 1997. The Wildlife Act 1976 is the main statute governing the protection of wildlife in Ireland and was amended in 2000 to take account of European law, particularly the Habitats and Birds Directives. The Wildlife (Amendment) Act 2000 also makes legal provision for the designation and protection of a national network of NHAs.

Once a site has been published as a proposed SAC or SPA, the Irish Habitats Regulations require that it be protected. The Habitats Regulations require the Minister for the Environment, Heritage and Local Government to undertake the appropriate steps to avoid deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated.

The Natura 2000 sites are required to achieve and maintain ‘Favourable Conservation Status’ (FCS) and measures must be designed to maintain or restore these habitats and species of Community interest. However, no timescale for these measures is specified.

DEHLG have recently (2008) reported on the status of EU protected habitats and species in Ireland following an assessment of FCS. On assessing the habitats listed in Annex I of the Habitats Directive, the conservation status of a natural habitat was taken as favourable when:

- its natural range and the areas it covers within that range are stable or increasing; and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- the conservation status of its typical species is favourable.

The NPWS aim to draw up conservation management plans for all areas designated for nature conservation which include descriptive information about a site and a management framework which outlines objectives and strategies of conservation within the area. Maps are produced to accompany the text including indicative habitat maps. Work is currently concentrating on compiling plans for SACs including updating and re-formatting old draft conservation plans, as well as writing new plans.

Habitats and Birds Directives and Marine Morphology

The WFD requires that Member States achieve compliance with any standards and objectives of Natura 2000 sites containing protected water dependant habitats and species by 2015 at the latest. As noted in section 10.1, DEHLG have advised that the failure of a water body to achieve the water related objectives of a protected area associated with a surface water body will result in the surface water body being classified as less than good regardless of whether other objectives are met.

Specific morphological objectives are not outlined by these directives or associated national legislation, and it is considered difficult to relate the aspects of FCS, as outlined above, directly with morphological attributes.

The ongoing development of conservation management plans for SACs and SPAs is considered fundamental to the future consideration of morphology as an important ecological quality element of coastal habitat such as saltmarshes, dune systems etc. Within the existing template of these plans, a section is dedicated to a site's 'physical characteristics'. This provides a suitable opportunity for specific monitoring and reporting of any morphological conditions supporting the existing conservation status.

The Floods Directive (2007/60/EC)

The Floods Directive aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. The Directive requires Member States to first carry out a Preliminary Flood Risk Assessment by 2011and to identify the river basins and associated coastal areas at risk of flooding. For such zones Member States are required to draw up Flood Risk Maps by 2013 and establish Flood Risk Management Plans to focus on prevention, protection and preparedness by 2015. This is designed to be integrated with the second RBMP in 2015. The directive applies to inland waters as well as all coastal waters across the whole territory of the EU and to all forms of flooding.

Under the Floods Directive and Ireland's National Flood Policy, a series of studies and plans are being prepared in response to concerns over sea level rise and climate change. As part of these programmes, Catchment Flood Risk Assessment and Mapping

Studies (CFRAMS) are being carried out. This will assist in developing a strategic information base necessary for making informed decisions in relation to managing flood risk and identifying viable measures and options for managing flood risk across a catchment, including associated coastal and estuarine areas.

Once completed, strategic Catchment Flood Risk Management Plans will be prepared (together with associated Strategic Environmental Assessment) and set out the measures and policies that should be pursued by local authorities and OPW to achieve the most cost-effective and sustainable management of flood risk within the CFRAMS areas.

The Floods Directive and Marine Morphology

Measures designed to alleviate flooding or provide flood protection, may have a significant impact on morphology and affect any measures proposed to assist the restoration or maintenance of water body status. Article 4 (7) of the WFD sets out the conditions under which a Member State will not be in breach of the directive when, ***inter alia,*** failure to achieve GES/GEP or prevent the deterioration in the status of a water body is the result of "***new modifications to the physical characteristics of a water body***" or when failure to prevent deterioration between high and good status is the result of "***new sustainable human development activities***". The potential relationship between proposed measures and conditions of such a directive are detailed in Section 11.1.2 of the following chapter.

It is considered that any flood risk management plans will be subject to SEA and EIA evaluation of the potential significant environmental and cumulative effects, and therefore adequately consider the potential for ecological deterioration associated with alterations to morphology.

Integrated flood planning may be required in the future due to the complexity of the issues involved. In addition to the CFRAMS areas, the possible cumulative interactions of neighbouring programmes on coastal processes should also be considered.

Pending European Directives

The Marine Strategy Directive (draft)

The consolidated text of this directive has been agreed by the EU Parliament and Council. The Marine Strategy Directive aims to achieve good environmental status of the EU's marine waters by 2021 and to protect the resource base upon which marine-related economic and social activities depend. It will establish European Marine 'Regions' on the basis of geographical and environmental criteria which will be assessed and managed by Marine Strategies.

The Marine Strategies, similarly to the Water Framework Directive's RBMPs, will contain a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level, and the establishment of clear environmental targets and monitoring programmes.

The MSD and Marine Morphology

As with the WFD, each Member State will draw up a programme of cost-effective measures, which will include the consideration of morphology.

In Ireland there is currently little information available on the larger sedimentary systems around the coast and sediment cells and pathways and the Sea Change Programme (MI, 2006) has defined the need for resources to fill these data gaps.

It is likely that coastal and marine process assessment (including monitoring) will be included as a recommendation or measure under the Marine Strategy Directive. As with TraC water bodies defined for the WFD, there is a significant gap in the monitoring and assessment of the relationship between morphology and ecology.

The Marine Strategy Directive is consistent with the requirements of the WFD. It is envisaged that this directive will help complement the achievement of the WFD objectives by increasing the awareness of coastal pressures, as well as outlining requirements for integrated strategic marine management.

The Environmental Liability Directive (ELD) (2004/35/EC)

Ireland is currently transposing the Environmental Liability Directive (2004/35/EC). The Directive is directed at preventing environmental damage to water resources, soil, fauna, flora and natural habitats, in accordance with the 'polluter pays' principle. The ELD introduces a liability scheme which aims to:

- hold operators whose activities have caused environmental damage financially liable for remedying this damage; and
- hold those whose activities have caused an imminent threat of environmental damage liable for taking preventive actions.

Under the ELD 'environmental damage' includes damage to protected species and natural habitats, water damage and land damage. Of potential relevance to morphology 'environmental damage' can include damage:

- which has significant adverse effects on reaching or maintaining favourable conservation status of species and natural habitats protected under EU legislation;
- that significantly adversely affects the ecological status and/or ecological potential of waters falling within the scope of the Water Framework Directive.

The ELD also includes an optional provision for the extension of the protection of habitats and species beyond those listed in the Birds and Habitats Directives (Article 2(3)(c)).

The ELD and Marine Morphology

This directive will help support the protection and restoration of morphological conditions by allowing specific detrimental effects to be appraised. Where remediation is required for 'environmental damage', the developer of a physical modification, and / or the regulator which approved such a development, could be held liable for the costs of rectifying, remediating or mitigating the situation. Unlike impact assessments, any actions (intervention measures) required are determined retrospectively, after the incident or development has occurred, and funded based on the polluter pays principle.

The appraisal of detrimental effects relating to morphology, and allocation of responsibility for this 'environmental damage' will require extensive evidence of the relationship between morphology and ecology. This again emphasises the importance of establishing a good baseline of morphological conditions for Irish TraC water bodies.

The risk assessment carried out by the Marine Morphology study can assist in this appraisal. However, further research and development including the monitoring and formal classification of TraC waters would be required to support liability decisions.

10.2.2.3 Governing Legislation – National, Regional and Local Levels

The following outlines relevant Irish national legislation. For each piece of legislation an assessment is made of the relevance to morphology regulation and where it may be possible to introduce additional measures.

The Foreshore Act

The Foreshore Act 1933 defines the foreshore as ***"the bed and shore, below the line of high water of ordinary or medium tides, of the sea and of every tidal river and tidal estuary and of every channel, creek and bay of the sea or of any such river or estuary***".

Within the Foreshore Act amendments, there have been changes to assist the protection of morphology. The Foreshore Act, 1992, amends the 1933 Act to increase penalties for breaches of the Act and gives the Minister (to be reassigned under current departmental changes) powers to ban sand or stone removal from any beach or classes of beach; to ban any specified method of sand removal; to control the quantities or times of any removal or disturbance; and to ban any activity or vehicle which disturbs the shore, e.g. by laying it open to wind or tidal erosion or by damaging indigenous plant or animal life or by taking from its amenity value. Assessments are made under the advice of the Marine Licence Vetting Committee (MLVC), a multi-disciplinary committee composed of representatives from DAFF, DEHLG, Department of Transport (DoT), NPWS, the Marine Institute, BIM, the Marine Survey Office, and the Central Fisheries Board. The committee has expertise in fisheries, biology, chemistry, oceanography, navigation and engineering disciplines and assesses in detail all permit applications prior to making a recommendation to the Minister.

The principal legislation currently of relevance to coastal protection works consists of the Foreshore Acts 1933-92, the Planning and Development Acts 2000 - 2006, and Harbours Acts 1946- 96.

The Foreshore Act and Marine Morphology

Many foreshore developments that require a foreshore licence/lease under the Foreshore Acts will impact marine morphology. The scale of the proposal will determine the requirement for an EIS. However, there is a requirement for a detailed support document for all foreshore applications that includes requirements for the evaluation for potential interactions and identification of any significant environmental affects.

Governmental guidance for foreshore (and dumping at sea) applications strongly recommends applicants to consult with the Department (DAFF at the time of writing) prior to finalising their application. Therefore, although there is currently no specific requirement for the consideration of morphology in this guidance, the obligation for appropriate consultation provides an opportunity to ensure the potential significance of marine morphology is raised.

Chapter 11 recommends more specific [supplementary] measures to enhance and support the existing regulatory framework for future physical modifications, including the appropriate use of the deliverables of this study and the TraC-MImAS tool.

The Dumping at Sea Acts 1996 – 2006*

** Collective citation as per section 1(7) of Sea-Fisheries and Maritime Jurisdiction Act 2006 (No.8)*

In 2006, the former DCMNR arranged with the Attorney General's Office for a formal Reinstatement of the following acts:

- The Dumping at Sea Act 1996 (No. 14 of 1996)
- The Dumping at Sea (Amendment) Act 2004 (No.35 of 2004)
- Section 103 of the Sea-Fisheries and Maritime Jurisdiction Act 2006 (No. 8 of 2006)

Currently in draft form, this consolidation of acts aims to assist those applying for Dumping at Sea permits and their consultants.

Dumping at sea is regulated under the Dumping at Sea Act, 1996. This Act implements the OSPAR Convention which was adopted in 1992 and entered into force in 1998 and which provides for strict controls on dumping of material in Irish waters. All permit applications for the dumping of dredge spoil at sea are processed by DAFF and the Coastal Zone Administration Division. The relevant Minister (currently DAFF) may decide to grant or refuse to grant a dumping at sea permit. This decision is informed by the recommendations of the Marine Licence Vetting Committee (DAFF, Guidelines for Dumping at Sea, 1999) and following consultation with the other bodies which the Minister considers appropriate.

The Marine Institute above behalf of DAFF has published comprehensive guidelines for the assessment of dredge materials for disposal in Irish waters (Cronin et al, 2006). Although this concentrates for the most part on contamination issues, the importance of the assessment of the physical characteristics of the materials is outlined.

The assessment of applications to dump at sea is carried out under the criteria laid down under the OSPAR Convention as set out in the First Schedule to the Dumping at Sea Act, 1996. Briefly, these criteria are:

- The availability, or otherwise, of suitable land-based alternative disposal options or there being other possible beneficial uses of the material (e.g. land reclamation, beach nourishment, etc.);
- The characteristics and composition of the material to be dumped;
- The characteristics of the dumping site and method of disposal;
- Potential interference with other legitimate uses of the area including fisheries, aquaculture, areas of special scientific importance, areas of wildlife importance, recreation, navigation and shipping both from the dumping and dredging aspects of the proposed project;
- Potential impact on the marine ecosystem.

Under the existing assessment process for dumping at sea, the dredge area analysis considers the physical as well as chemical and biological characteristics of the material to be removed.

The dump site is then assessed for potential impact and interaction. Applications for permits are required to provide information on the location of the dump site in relation to the vicinity of such sites as:

- Spawning, recruitment and nursery areas.
- Sport and commercial fishing areas.
- Aquaculture areas.
- Amenity areas.
- Exploitable resources, e.g. aggregate.
- Areas of special scientific importance.
- Areas of wildlife importance / preservation.
- Shipping lanes.
- Shipwrecks.
- Sites of archaeological interest.
- Engineering uses of the sea such as undersea cables, pipelines, etc.

The licence applicant must provide data on the hydrological characteristics of the dump site as well as data on benthic fauna. In some cases (usually for proposed new dump sites) the applicant will also need to carry out field and model studies to obtain these data for the evaluation of the physical characteristics of the dumpsite, including:

- Water depths (maximum, minimum, mean).
- Water stratification in various seasons and weather conditions.
- Tidal period, orientation of tidal ellipse, velocities of major and minor axis.
- Mean surface drift (net): direction and velocity.
- Mean bottom drift (net): direction and velocity.
- Wind and wave characteristics.

The Dumping at Sea Acts and Marine Morphology

The Dumping at Sea Act contributes to the control of both dumping at sea and dredging (maintenance and capital) activities.

The control of dumping at sea includes requirements to report on the hydro-morphological characteristics of the dump site, providing not only a direct assessment of morphological impact, but a source of potentially important baseline data.

The MLVC assess both dumping at sea permits and foreshore licence applications, which should allow the existing mechanisms to be used for a cross sectoral cumulative appraisal of proposed developments affecting marine morphology.

Based on the summary above it is considered that morphology is appropriately addressed by the Dumping at Sea Acts and associated guidance documents.

Planning and Development Acts 2000 - 2006

The Planning and Development Act requires local authorities to prepare a development plan for their area. This consists of a written statement and a plan indicating the development objectives for the area in question. It also acts as a framework within which planning applications are made and planning permissions granted or refused, i.e. a proposed development must be in accordance with the purpose for which the site is zoned in the relevant development plan. Under the SEA Directive, these plans (County Development Plans and Local Area Plans) must be associated with a SEA. This enables the assessment of sustainable development, and potential cumulative impacts. It also provides a framework for public consultation.

The Planning and Development (Strategic Infrastructure) Act, 2006 amended the Planning and Development Act, 2000 to allow for a series of changes to the planning and judicial procedures associated with large infrastructure projects, i.e. for developments specified by this Act the applicant shall apply directly to An Bord Pleanala for planning permission rather than to the Local Planning Authority in which the development is proposed

Although the Strategic Infrastructure Bill allows the ‘fast-tracking’ of developments which are seen to have significant public interest, it does not preclude requirements for EIAs or SEAs.

Subject to the scale of a proposed project, an application for planning should be accompanied by an EIS.

Planning and Marine Morphology

Potential measures for the further consideration of morphology in the planning system are addressed by the EIA and SEA summaries above, which are detailed specifically in Sections 11.1.1, and 11.2 of Chapter 11).

National Spatial Strategy and National Development Plan

Regional guidelines and development plans in Ireland (Local and County Development Plans) must take into account the National Spatial Strategy. The National Spatial Strategy is a national planning framework for Ireland from 2002-2020. The key to the strategy is balanced regional development. It is intended that the Strategy will guide ***'future infrastructural, industrial, residential and rural development in Ireland while providing protection for our cultural, natural and environmental heritage'.***

The National Strategy also takes account of the European Spatial Development Perspective, agreed in 1999 by the 25 EU member States, and enacted under the National Development Plan.

Integrated Coastal Zone Management

Both the National Spatial Strategy and the National Development Plan encompass many principles of Integrated Coastal Zone Management (ICZM), but do not include a specific plan for adopting an ICZM process. The NDP (2000-2006 and 2007-2013) outlines the principles of ICZM and its benefit in managing coastal erosion and deposition, sea level change, coastal land use and development, and maritime industries including fisheries, aquaculture, offshore energy production, tourism and recreation, making reference to the Coastal Zone Management: Draft Policy for Ireland (1997). Under the Marine Institute Sea Change Programme the NDP (2007-2013) has initiated research into the phased introduction of ICZM in Ireland, referencing the River Basin Management Plans as an integral factor.

ICZM is a strategic integrated management system, using the existing regulatory and non-regulatory bodies and structures. ICZM has been defined as a dynamic, continuous and iterative process designed to promote sustainable management of coastal zones. ICZM seeks, over the long-term to balance the benefits from economic development and human uses of the coastal zone, the benefits from protecting, preserving and restoring coastal zones, the benefits from minimising loss of human life and property, and the benefits from public access to and enjoyment of the coastal zone; all within the limits set by natural dynamics and carrying capacity (EC, 1999, EC, 2000)

ICZM and the WFD

River Basin Management Planning adopts many of the principles of ICZM. However, it is considered that the natural dynamics and coastal processes of Ireland's coastline are not sufficiently understood to allow ICZM to be fully established. There are also sectoral and departmental divides that would require further integration to allow ICZM to be practiced effectively in Ireland.

The NSS, NDP and Marine Morphology

The NSS and NDP highlight the need for coastal infrastructure. The various programmes include development of coastal tourism, sea transport, security of oil and gas supplies, renewable energy and a range of other objectives that will entail coastal development and therefore morphological pressure. However, the programmes also identify the need for ICZM, cross sectoral management based on the management of areas by catchment (RBMP areas) and physical processes, and outlines needs for research and implementation programmes. ICZM is an important measure highlighted in many European and National strategies and legislation. It provides a significant management measure for marine morphology integrating the existing mechanisms to provide effective management.

The National & Local Biodiversity Action Plans

In response to the Article 6 of the Biodiversity Convention Ireland has developed a National Biodiversity Action Plan (2002). This 91 point approach is designed to assist the preservation of biodiversity on a national basis. Plans are currently being developed for specific areas of biodiversity such as the 'National Plant Biodiversity Strategy'. The Plan recognises that the WFD will compliment some of its recommendations.

There are limited Local Biodiversity Action Plans in Ireland. Where developed, these Plans have been generated predominantly to support and inform County Development Plans; primarily as a conservation plan to accompany the environmental report for the plan. This approach provides guidance at a local authority level on evaluation of the development plan and future developments.

The National Biodiversity Action Plan and Marine Morphology

The recommendations of the National Biodiversity Action Plan are consistent with the objectives of the WFD and should be considered as a supportive measure, particularly as much of the Convention is aimed at ecological awareness and education.

Where the biodiversity targets of Local Plans correspond to morphologically sensitive habitats and species these plans may assist in raising awareness, however, as they are applied inconsistently across Ireland at the present time it is considered that the NPWS Conservation Management Plans may provide a better approach for morphological assessment of habitats.

Local Authorities (Bye-Laws)

In addition to the powers described above, national Planning and Development Regulations allow local authorities to rule on local bye-laws to control activities in coastal areas. Several local authorities currently have Beach Bye Laws, enacted under Part VII of the Local Government Act, 1994 to prevent activities such as off road vehicles, power boats or jet-ski operations on certain beaches or areas. These also extend to a wide variety of activities such as vehicle access and recreational activity areas. The driver for many of these is safety or nuisance, but there is the facility to use these laws to protect morphology (especially coastal areas of high ecological value such as dune systems or saltmarshes) from activities affecting morphology.

10.2.2.4 Guidance

In addition to Governmental guidance, many sectors across Europe produce detailed guidance specific to their sector's applications and developments. The Good Practice Guide provided by Chapter 7 of this report summarises much of this guidance where relevant to morphology, and helps direct the reader to the most appropriate guidance in considering the pressures identified.

Under the Environmental Protection Agency Act, 1992, the EPA has departmental responsibility for the production of guidance for environmental legislation. Much of this guidance has been produced and between the government departments there are a number of guidelines covering the requirements, assessment and processes for EIA, SEA licensing, permission permit systems, sectoral guidance for specific industries such as the construction industry, and specific mitigation that can be carried out on types of development.

Much of this guidance has been reviewed over the course of this study, and examples are highlighted in Chapter 7. In general, there has been little mention of morphology as an issue of concern. This is presumably due to a lack of awareness of the implications to ecology of morphological change. Unlike other European countries where the coastal processes are well understood and managed (enabling more specific guidance, evaluation, and prioritisation of protection of resources) Ireland's coast is much less understood than other areas and often information and data is deficient (see Chapter 3 – Data Review and Chapter 4 – Review of Existing Monitoring).

The National Roads Authority's 'Environmental Assessment and Construction Guidelines' is a good example of comprehensive sectoral guidance including detailed appraisal of the EIA process in Ireland. The structure and content of these guidelines provides the reader with all the information required to appropriately consider the potential environmental issues in relation to existing legislation as well as consider the available and appropriate measures to minimise environmental impact. Such guidelines, adapted for coastal development, would significantly enhance the success and efficiency of the existing mechanisms governing Ireland's TraC water by providing developers, consultees and regulators with the appropriate tools for assessment.

Significantly, the EC and other European countries have provided guidance on coastal zone management, its principles and implementation. In much the same way as the River Basin Management Plans are intended to provide integrated management over an area determined by physical factors rather than administrative boundaries, ICZM is designed to do the same on the basis of natural coastal process delineators. Within the UK for example, successful coastal assessment programmes have been based on coastal cells, or areas derived from the coastal processes.

The drivers for this process have been the high level of coastal development and modification. Whilst Ireland does not have the same levels of coastal development as its EU neighbours, the process of ICZM has significant value in integrated management, which is a key component for marine morphology management in Ireland. Within the UK these are then managed under a framework to allow integrated management with regard for strategic and coastal processes (affecting morphology).

An example of the integration of management plans for the UK is shown below in Figure 10.1, a process for which RBMPs can benefit.

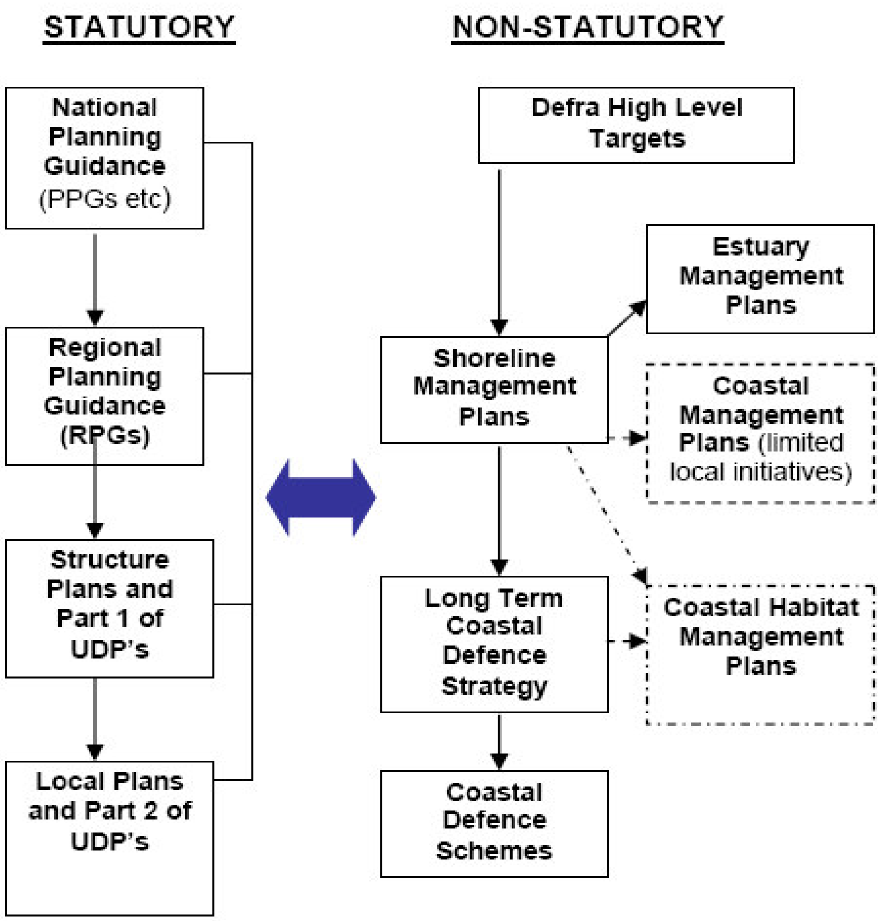


Figure 10.1: An example of coastal plan integration and guidance from the UK (DEFRA, 2002 ICZM in the UK: A Stocktake)

10.2.3 Conclusions from Legislative Appraisal (Basic Measures)

Ireland has a complex legislative framework covering foreshore areas with crossover of responsibilities and duplication in some areas, and there is potential for developments with possible morphological effects to occur below current thresholds for further assessment.

Ireland has a potential regulatory gap in relation to managing direct morphological pressures consistently across Ireland's TraC waters. This is not unusual across Europe; however departmental responsibility changes have complicated this issue in Ireland. The Foreshore Acts are currently the only significant piece of Irish legislation considering morphological pressures in TraC water bodies. Also there are few mechanisms for strategic overview, especially covering the foreshore and the determination of cumulative affects.

There is a general lack of awareness of morphology as a significant environmental impact within the existing regulatory system, but by raising awareness and supplementing existing guidance, morphology can be highlighted as an important consideration within the current legislative framework.

The implementation of the WFD will ensure morphology is considered as a significant environmental factor within the RBMPs. However, considering the findings outlined above, additional measures are required to ensure marine morphology is adequately addressed within the appropriate areas of development appraisal (see Chapter 11 for recommendations and an example of how this may be achieved).

The current legislation has a strong marine / land divide, and elements of departmental uncertainty compound this problem. The current legislation emphasis is on sectoral implementation of planning, and although there are some common or overarching regulatory structures, they are not utilised for cross sectoral or strategic appraisal.

For marine morphology and other TraC issues to be effectively managed, there is a **real need for clear and transparent mechanisms to implement legislative requirements and ensure enforcement and compliance**.
In the absence of a single marine or water department, the regulatory responsibilities, requirements, and interactions need to be clearly defined and suitable guidance provided, with a common structure from local through to national development appraisal and control.

10.3 Recommendations for Basic Measures and Supplementary Measures

The legislation outlined in Section 10.2 above can require / benefit from the application of various actions to assist compliance. Chapter 7 of this report details the Good Practice measures appropriate for the restoration and mitigation of morphological conditions in TraC waters. In addition to these the following measures relating to the enhancement of existing legislative mechanisms are proposed:

- A **detailed review of marine legislation should be undertaken**, identifying gaps and crossover. This should be carried out once departmental responsibilities are confirmed (budgeted and scoped under the Sea Change Programme (NDP2007-2013)). This review was tendered by the DCENR in 2007 but has been deferred until such time as departmental responsibilities can be confirmed. This review will assess the legislative controls relevant to marine management and the development and maintenance of coastal structures (marine morphological pressures). This review also constitutes one of the essential initial stages of ICZM under the European guidelines. Without this information, gaps in the current regulatory structure, and associated guidance, cannot be sufficiently identified for marine morphological pressure regulation to propose effective measures or assess compliance with basic measures. Consideration should also be given to the potential conflict between existing legislation, for example, the requirement under the Harbour Acts for the maintenance of channels could potential conflict with PoMS defined to meet the objectives of the WFD.

- **Consideration of morphology should be included under the interaction evaluation requirements of the SEA, EIA, Foreshore Licensing and Dumping at Sea permitting systems**, by amendment of the existing guidelines by the appropriate responsible department (currently EPA and DAFF).

- **Requirements under the current legislative framework should be expanded to include more emphasis on strategic evaluation and cumulative assessment** (especially with EIA and SEA appraisal). The cumulative impacts should also be considered by the regulatory authority and the Aquaculture and Marine Licence Vetting Committee who evaluate all the licences, and include representatives from all relevant government bodies.

- Certain **permit, licence, or permission activities** currently have detailed guidance on adherence to the existing legislative mechanisms. While the guidance adequately addresses the requirements of the legislation specific reference to morphology is rare. Within these current mechanisms, morphology can be considered as a 'significant environmental factor', or as a 'significant interaction'. **Changes to the guidance for preparing and evaluating these applications to include morphology** will increase awareness and promote its assessment from project to strategic level, helping to ensure preservation of ecological status of TraC water bodies.

- It is envisaged that many of the responsibilities for foreshore and marine development will be passed on to **local authorities**; or they will be involved in consultation through the RBMP process and existing legislation. This will enable **morphological evaluation to be undertaken at River Basin District level**. Until such time as further research, co-ordinated by the Marine Institute or DAFF, has been carried out into the phased introduction of Integrated Coastal Zone Management as proposed under the Sea Change Programme (NDP2007-2013), this mechanism could provide much of the structure required for integrated marine management. As coastal processes occur and can be affected across a wide area and across river basin boundaries, this **integrated approach is fundamental to both assessment and management of coastal pressures**.

The above recommendations for measures are generic to TraC waters and primarily involve increasing morphology related assessment within the existing basic measures (mechanisms). On confirmation of the roles and responsibilities of governing bodies, the detailed aspects of these recommendations can be appropriately prioritised by further reviewing the current gaps identified with regard to feasibility and cost effectiveness parameters. Prior to this is it is considered that the **specific inclusion of morphology** and / or ecological status as a significant environmental factor / interaction **in national guidance documents for existing mechanisms** is a cost effective method of increasing the appropriate awareness of these aspects relating to the achievement of WFD objectives.

10.4 Prioritisation of TraC Water Bodies for the Application of Appropriate Measures

10.4.1 Introduction

As indicated in Section 10.1 above, a programme of measures is required to prevent deterioration in the existing status of waters, and restore water bodies currently at 'less than good' to 'good status' by 2015.

To achieve these objectives, this section aims to outline two methods to assist RBDs in the identification of appropriate PoMs to address morphological conditions of Irish TraC waters:

1. Section 10.5.2: A method is proposed outlining how TraC water bodies identified as potentially at risk of not achieving their required status under the WFD (in the absence of classification) can be prioritised for attention (Figure 10.2).
2. Section 10.5.3: An approach is recommended for the identification of appropriate measures for those water bodies identified (Figure 10.3). This method is based on Figures 7.2 and 7.3 in Chapter 7 which introduced recommendations for the identification of appropriate measures to improve and protect morphological conditions as well as any reporting requirements to support decisions made.

With regard to the both the development and use of these methods, the following aspects have been, and should continue to be, addressed throughout the prioritisation:

- Significant risks associated with these water bodies (identified via further characterisation of pressures and the use of TraC-MImAS)
- Effectiveness of existing measures (identified via Chapter 7, Sections 10.2 – 10.3 above, as well as in Section 11.2.1 of the following chapter)
- Measures to address any gaps in meeting the required objectives (see Chapter 7 regarding physical actions, and Chapter 11 and Sections 10.2 and 10.4 regarding enhancement to existing mechanisms)
- Technical feasibility and cost associated with achievement of objectives by 2015.

As noted previously, hydromorphological quality elements must be taken into account when assigning water bodies to the HES class. For other status classes, the hydromorphological elements are required to have '***conditions consistent with the***

achievement of the values specified for the biological quality elements' (WFD, Annex V). Only when the required biological and physico-chemical conditions are met is hydromorphology addressed. Prior to the formal classification of TraC water bodies, it is assumed for the purpose of this chapter that PoMs summarised in the first RBMP (2009 – 2015) will focus on those water bodies characterised as 'at risk' from 'other factors' such as pollution or marine direct impacts (nutrients and hazardous substances) in order to achieve at least good ecological status. Morphology will then only be required for the achievement of high ecological status. The hierarchy relating to the achievement of GES and HES is illustrated in Figure 1.1 of Chapter 1.

On completion of all national PoMS studies and formal classification, each RBD should be adequately informed to determine the cumulative impacts of identified pressures on the status of TraC water bodies. PoMS can then be focused on those water bodies of highest priority subject to technical feasibility and cost. Comprehensive prioritisation of specific morphological measures is not a feasible deliverable of this study given the information available at the time of writing. However, the recommendation of a method for prioritising TraC water bodies as well as a process for identifying appropriate generic measures to achieve the objectives of these water bodies, will provide RBDs will sufficient information for the consideration of morphology in the design the PoMs.

Order of Priority

Following consultation with the Marine Morphology Steering Group and a review of the requirements of the WFD, prioritisation of TraC water bodies for the application of morphology measures were considered under the following themes in order of priority:

1. Restore high morphology status in any TraC water bodies where 'protected area' favourable conditions***** require high status (Article 4(i)c of the WFD and DEHLG request);
2. Preserve high status in existing high status TraC water bodies by controlling new development (Article 4(i)a of the WFD);
3. Preserve good status in existing good status TraC water bodies by controlling new development (Article 4(i)a of the WFD);
4. Restore good morphology status in any TraC water bodies that would otherwise be of good status (this implies that all other water quality elements are at least good status) (Article 4(i)a of the WFD).

* the purpose of this study, and this prioritisation 'favourable status' is considered as Favourable Conservation Status of Natura 2000 sites.

Sources of Information

Information to further assist the prioritisation process will be made available to the RBDs on completion of all PoMS studies, many of which were undertaken at a national level, also formal classification and monitoring results will be provided by the EPA.

With regard to morphology, the information required to apply the methods recommended here is summarised below under the following themes:

- Status class
- Pressures
- Protected Areas
- Measures
- Technical feasibility
- Cost

Where this information is currently unavailable, an alternative source is identified, and where appropriate, the responsible body for providing this information is noted.

The information available at the time of writing was used to apply the recommended method so as to demonstrate indicative results of this prioritisation (Tables 10.1 and 10.2).

Before definitive PoMs relating to morphological alterations can be concluded, additional monitoring and appraisal of the pressures, as outlined in Chapters 9 and 3 respectively, should be undertaken. It is recommended that on receipt of such information the prioritisation methods are validated and re-run where required.

Status Class

The EPA will provisionally classify TraC water bodies in the RBMPs. Then, following completion of the inter-calibration exercise and validation of new classification tools, the EPA will assign final status classes by March 2011 (DEHLG, 2007). Prior to the classification of TraC water bodies, the results of the Further Characterisation process, as outlined in Chapter 6 of this report, can be used to help prioritise waters for the design and application of PoMs regarding morphology. These results are subject to the assumptions outlined in Section 6.2.1 and 6.3.

Pressures

The morphology pressures identified throughout this study are documented in GIS layers. The extent of these pressures once assessed within TraC-MImAS is expressed as risk to status class. In the absence of formal classification tools and reference conditions / thresholds for morphology the TraC-MImAS morphological condition limits (refer to Section 5.2.5) can be used as indicative of status class targets. The gap between the estimated risk status and these targets can be then gauged, i.e. is an objective of preservation or restoration of status required.

Prior to the completion of national PoMS studies, it was necessary to refer to the initial risk assessment results for the risk associated with 'other factors' ['at risk' (1a) and 'probably at risk' (1b)]. An appraisal of the risk associated with 'other factors' will be required prior to the implementation of measures.

As part of the further characterisation process, Water Body Summary Sheets were generated for TraC water bodies characterised as being at risk of failing to achieve GES. In addition to detailing the existing pressures on each water body, the physical and ecological characteristics including the presence of any protected areas were summarised (refer to Section 6.3.4 and Appendix 6-4). These reports will prove useful to the site specific assessment of pressures.

The recommendations of the Marine Morphology data review (Chapter 3, Section 3.5) should be considered on review of existing pressures identified for TraC water bodies.

Protected Areas

The DEHLG have specifically requested (as notified via the Marine Morphology Steering Group) that protected areas are given precedence for prioritisation. The Natura 2000 network designated via the Birds and Habitats Directives is recorded in Ireland's WFD Register of Protected Areas (RPA) as 'PA5' and 'PA6' respectively.

Legislation currently governing all other RPAs is not considered to be of particular relevance to morphology. For example, RPAs associated with drinking water will not be subject to more stringent objectives than the WFD with regard to TraC morphology. Legislation of relevance to both shellfish and salmonid RPAs outlines restrictions to suspended solids. However, water pollution is considered the main pressure regulated here. It was therefore considered appropriate that, in reviewing the proximity of TraC water bodies to protected areas and the potential for more stringent objectives required of morphological conditions, that Natura 2000 sites were of most relevance. Any TraC water bodies designated as SACs or SPAs which requiring a conservation status equivalent of high ecological status should be subject to measures to achieve this status as a first priority.

At the time of writing, Ireland's WFD Register of Protected Areas had yet to be finalised. In relation to this register, the Western River Basin District (WRBD), as part of the High Status PoMs study, is currently preparing a database of water dependant habitats and species (SACs and SPAs), and following approval from the NPWS, a database and baseline data will be provided to the RBDs for consideration in PoMS. For sites identified as not achieving Favourable Conservation Status, the WRBD will report on set targets and timeframes for restoration and develop guidance on a suite of measures for the different habitats. The NPWS are to develop a webserver-based register of designated sites to which local authorities and other State agencies will have access (WRBD High Status presentation, National PoMS Co-ordination Meeting, April 2008). Once approved, those water bodies identified by this study will be required to maintain / achieve High Ecological Status by 2015.

In the absence of this information, and for the purpose of providing an example of the recommended prioritisation method, all water bodies within the vicinity of an SAC or SPA which have been identified as likely to achieve GES were evaluated as requiring one of two objectives:

- Improvement of status to HES for Favourable Conservation Status; or
- Preserve good ecological status.

Measures

Existing and recommended mechanisms for governing pressures within TraC water bodies are identified in Sections 10.2 and 10.4 above and outlined in detail in Chapter 11 with regard to future regulation.

As stated previously, aspects of the management of marine affairs within government departments in Ireland is currently undergoing change. Therefore, it is important to note that the legislation information summarised for consideration in this chapter (and Chapter 11) has been updated to be as accurate as possible at the time of writing, but, it is anticipated that changes will occur over the course of the first River Basin Management cycle.

A detailed review of marine legislation as recommended by the National Development Plan (NDP) Sea Change Programme (NDP2007-2013) is a potential contributor to this change if completed in the near future. This review was tendered by the DCENR in 2007 but has been deferred until such time as departmental responsibilities can be confirmed. If undertaken, this review will assess the legislative controls relevant to marine management and the development, and maintenance of morphological pressures, and propose resolutions for the gaps identified in Sections 10.2 and 10.3 above.

The identification of specific pressure types has helped define appropriate measures (physical actions) for the restoration and mitigation of morphological alterations (as outlined in the Good Practice Guide in Chapter 7). In addition to associating suitable measures to each pressure type, the Good Practice Guide directs the user to sources of information which can aid decisions for both the maintenance and restoration of status.

Existing voluntary programmes, such as local environment schemes, may also be active in a water body, contributing to its quality. Such information should be obtained on a local, site-specific basis.

Technical Feasibility

Technical challenges of implementing various measures on the ground were identified where possible through the review of case studies and reported in the Good Practice Guide in Chapter 7.

As recommended in Chapter 7, in reviewing the feasibility of measures, it is important to emphasise that measures, which have proven successful at one location, may not be directly applicable in other environments. Also, the implementation of morphology measures, particularly those required for the restoration of status, can potentially result in adverse impacts on other quality elements.Therefore, in deciding on the most appropriate measures, site specific investigations and designs should be considered in the context of a wider strategy, i.e. linked to sustainable developmental appraisal, through appropriate assessment in existing legislative guidance under EIA and SEA, as well as the RBMPs.

Costs

The cost effectiveness of implementing morphological pressures is addressed in Chapter 7. In summary, those measures achievable at minimum cost typically include the development or application of codes of practice and better enforcement of (often existing) local regulation. Measures prohibiting certain activities or work methods, such as dredging, may be shown to be disproportionately costly particularly when considered in the context of the wider strategy.

Also those costs associated with the maintenance of some measures should also be considered. This may be particularly relevant to those measures required to maintain conservation site.

Where possible, the costs of implementing protective, restorative and enhancement measures have been identified in the Good Practice Guide in Chapter 7. New basic measures or legislative supplementary measures, if required, will generally be subject to Regulatory Impact Assessment (RIA).

Costs can assist in the prioritisation of measures. However, they are best used on a site specific basis where the measures can be accurately assessed. Excessive costs are easier to identify for mitigation where they can be assessed against the total cost of the development.

The Good Practice Review can assist RBDs in reviewing potential costs. However, detailed field assessments will be fundamental to the assessment of each measure proposed.

10.4.2 Prioritisation of TraC Water Bodies

Figure 10.2 below illustrates how Irish TraC water bodies can be prioritised for the consideration of morphology measures. As noted above, additional information sourced from the completion of the PoMS studies, monitoring programmes and classification will supplement the application of this method, and should be considered by each RBD during the design of the PoMs.

In the absence of the above, the best available information at the time of writing was used to apply this method to the TraC water bodies in order to predict the potential default objectives for each of the water bodies. Those steps illustrated in ***italics*** in Figure 10.2 indicate where alternative information was used in the absence of a more appropriate source.

Tables 10.1 and 10.2 outline the results of this method of prioritisation by identifying the likely objectives for each water body as per the themes below:

1. Restore high morphology status in any TraC water bodies where ‘protected area’ favourable conditions require high status.
2. Preserve high status in existing high status TraC water bodies by controlling new development.
3. Preserve good status in existing good status TraC water bodies by controlling new development.
4. Restore good morphology status in any TraC water bodies that would otherwise be of good status (this implies that all other water quality elements are at least good status).

Appendix 10-1 tabulates these results for each RBD.

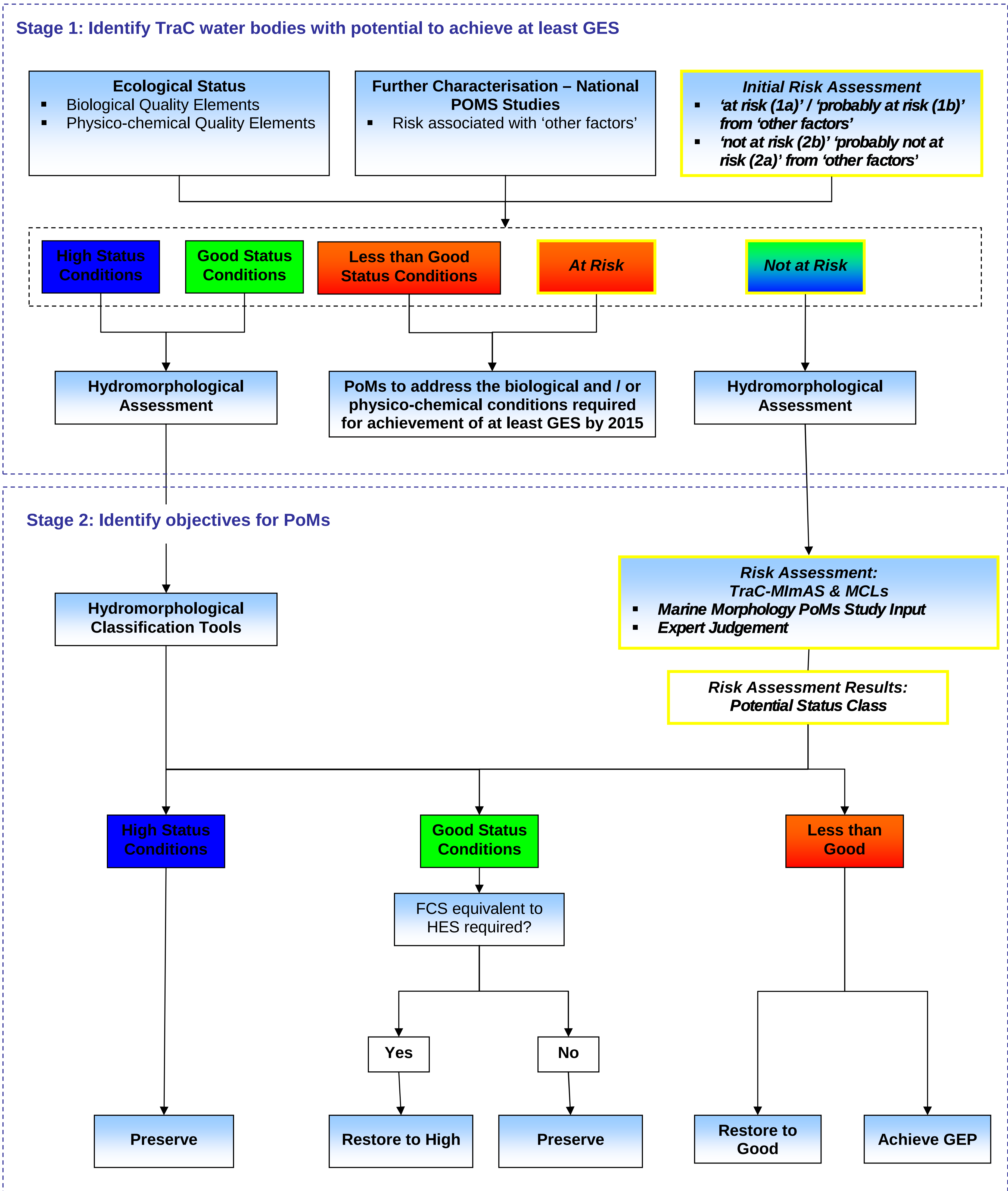


Figure 10.2: Method for the prioritisation of TraC water bodies to assist in the identification of appropriate measures

Stage 1 – Identify TraC water bodies with potential to achieve at least GES

Firstly the biological and physico-chemical components of ecological status of a water body should be determined. There are currently three sources for this information: provisional classification results to be provided by the EPA; further characterised risk determined by national PoMS studies; and initial risk estimates, i.e. water bodies identified as 'at risk' or 'probably at risk' of failing to achieve GES by the initial risk assessments (2004/2005).

Those water bodies identified as potentially achieving high or good ecological status based on these elements, or found not to be at risk of failing to achieve these status classes should then undergo an assessment of hydromorphological conditions (Stage 2).

As a priority for compliance with the WFD, PoMs are likely to focus on the restoration of the biological and physico-chemical conditions to achieve at least GES by 2015. Water bodies found to be at risk of failing to achieve high and good status, or confirmed as less than good, due to the biological and physico-chemical conditions should not require assessment of hydromorphological conditions.

Stage 2 – Identify objectives for PoMs

On completion of further development and approval of hydromorphological classification tools, the status of hydromorphology can be determined. Prior to these tools, TraC-MImAS can be used to support expert judgement in considering the existing status of hydromorphological conditions.

Following the use of either of these tools, those water bodies indicating potential to achieve high ecological status can be identified. These water bodies will require measures to ensure there is not deterioration of this status class (water bodies identified as priority '2' in Tables 10.1 and 10.2)

Those water bodies indicating good status can be subject to either of the following objectives depending on the presence and required status of protected areas:

- Restore to High if this is required for Favourable Conservation Status (water bodies identified as priority '1' in Tables 10.1 and 10.2)
- Preserve Good Status (water bodies identified as priority '3' in Tables 10.1 and 10.2)

Those water bodies indicating morphological conditions consistent with less than good ecological status can be subject to either of the following objectives which can only be determined following the assessment of technical feasibility and cost:

- Restore to at least Good Status (water bodies identified as priority '4' in Tables 10.1 and 10.2)
- Achieve at least Good Ecological Potential

Table 10.1: Coastal water bodies and predicted default objectives to help prioritise the application of measures to achieve these objectives

Water Body Code	Name	pHMWB	Type	Overall Risk expressed as likely Morphological Status Class	At Risk from Other Factors	SAC / SPA Present - Favorable Conservation Status	Objectives - Morphological Status	Priority - Morphological Status
IE_SH_040_0000	Outer Tralee Bay		CW5	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_060_0000	Inver Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_170_0000	Inner Galway Bay North		CW5	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_100_0300	White's Marsh		CW10	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_EA_070_0000	Irish Sea Dublin (HA 09)		CW5	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_350_0000	Inner Clew Bay		CW5	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_0000	Kilkieran Bay		CW5	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_100_0200	Inchydoney		CW10	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_110_0000	Ballyvaghan Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_260_0000	Mannin Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_400_0000	Broadhaven		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_405_0000	Belmullet Bay		CW8	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_140_0000	Dungloe Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_150_0000	Rutland Sound		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_160_0000	Gweedore Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_180_0000	Tory Island Waters		CW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_240_0000	Trawbreaga Bay		CW8	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SH_030_0000	Brandon Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SH_080_0000	Doonbeg Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_100_0000	Clonakilty Bay		CW5	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_140_0000	Roaring Water Bay		CW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_200_0000	Ballinskelligs Bay		CW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_210_0000	Portmagee Channel		CW8	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_220_0000	Valencia Harbour		CW8	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_160_0700	Rincarna Pools South		CW10	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_160_0710	Rincarna Pools North		CW10	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SE_050_0000	Eastern Celtic Sea (HAs 13;17)		CW2	High	No	TBC	Preserve	2
IE_NW_190_0000	Sheephaven Bay		CW5	High	No	TBC	Preserve	2
IE_SE_090_0000	Bannow Bay		CW8	High	No	TBC	Preserve	2
IE_WE_420_0000	Killala Bay		CW5	High	No	TBC	Preserve	2
IE_WE_360_0000	Blacksod Bay		CW5	High	No	TBC	Preserve	2
IE_NW_070_0000	Donegal Bay Northern		CW2	High	No	TBC	Preserve	2
IE_NW_120_0000	Gweebarra Bay		CW5	High	No	TBC	Preserve	2
IE_SH_060_0000	Mouth of the Shannon (HAs 23;27)		CW2	High	No	TBC	Preserve	2
IE_SH_010_0000	Southwestern Atlantic Seaboard (HA 23)		CW2	High	No	TBC	Preserve	2
IE_WE_460_0000	Ballysadare Bay		CW8	High	No	TBC	Preserve	2
IE_WE_450_0000	Sligo Bay		CW5	High	No	TBC	Preserve	2
IE_WE_430_0000	Donegal Bay Southern		CW2	High	No	TBC	Preserve	2
IE_SE_100_0000	Waterford Harbour		CW2	High	No	TBC	Preserve	2
IE_SH_100_0000	Liscannor Bay		CW2	High	No	TBC	Preserve	2
IE_SW_230_0000	Outer Dingle Bay		CW2	High	No	TBC	Preserve	2
IE_SW_110_0000	Rosscarbery Bay		CW5	High	No	TBC	Preserve	2
IE_NW_170_0000	Ballyness Bay		CW5	High	No	TBC	Preserve	2
IE_WE_310_0000	Killary Harbour		CW5	High	No	TBC	Preserve	2
IE_EA_020_0000	Northwestern Irish Sea (HA 08)		CW5	High	No	TBC	Preserve	2
IE_NW_220_0000	Lough Swilly		CW5	High	No	TBC	Preserve	2
IE_SW_170_0000	Outer Bantry Bay		CW2	Good	No		Preserve	3
IE_SW_060_1000	Raffeen Lake, Shanbally		CW10	At least Good	No		Preserve	3
IE_SW_080_0200	Kinsale Marsh, Commoge		CW10	At least Good	No		Preserve	3
IE_SW_140_0100	Ballyrisode Bridge Lagoon		CW10	At least Good	No		Preserve	3
IE_WE_010_0000	Aran Islands, Galway Bay, Connemara (HAs 29;31)		CW2	At least Good	No		Preserve	3
IE_WE_230_0000	Bertraghboy Bay		CW5	At least Good	No		Preserve	3
IE_WE_250_0000	Western Atlantic Seaboard (HAs 32;33;34)		CW2	At least Good	No		Preserve	3
IE_WE_300_0000	Ballynakill Bay		CW5	At least Good	No		Preserve	3
IE_WE_340_0000	Clew Bay		CW2	At least Good	No		Preserve	3
IE_WE_370_0000	Blacksod Bay SW / Achill Sound		CW5	At least Good	No		Preserve	3
IE_WE_380_0000	Bellacragher Bay		CW8	At least Good	No		Preserve	3
IE_EA_040_0000	Rockabill		CW5	At least Good	No		Preserve	3
IE_NB_025_0000	Louth Coast (HA 06)		CW5	At least Good	No		Preserve	3
IE_NW_010_0000	Donegal Bay (Erne)		CW5	At least Good	No		Preserve	3
IE_NW_080_0000	McSwines Bay		CW5	At least Good	No		Preserve	3
IE_NW_100_0000	Northwestern Atlantic Seaboard (HA 37,38)		CW2	At least Good	No		Preserve	3
IE_NW_110_0000	Loughros Bay		CW5	At least Good	No		Preserve	3
IE_NW_130_0000	Trawena Bay		CW8	At least Good	No		Preserve	3
IE_NW_150_0100	Sally's Lough		CW10	At least Good	No		Preserve	3
IE_NW_230_0000	Northern Atlantic Seaboard (HAs 40,02)		CW2	At least Good	No		Preserve	3
IE_SH_020_0000	Smerwick Harbour		CW5	At least Good	No		Preserve	3
IE_SH_060_1300	Scattery Island Lagoon		CW10	At least Good	No		Preserve	3
IE_SH_060_1400	Cloonconeen Pool		CW10	At least Good	No		Preserve	3
IE_SH_070_0000	Shannon Plume (HAs 27;28)		CW2	At least Good	No		Preserve	3
IE_SW_010_0000	Western Celtic Sea (HAs 18;19;20)		CW2	At least Good	No		Preserve	3
IE_SW_020_0000	Youghal Bay		CW5	At least Good	No		Preserve	3
IE_SW_080_0000	Kinsale Harbour		CW5	At least Good	No		Preserve	3
IE_SW_090_0000	Courtmacsherry Bay		CW5	At least Good	No		Preserve	3
IE_SW_120_0000	Fastnet Waters		CW2	At least Good	No		Preserve	3
IE_SW_150_0000	South Western Atlantic Seaboard (HAs 21;22)		CW2	At least Good	No		Preserve	3
IE_SW_160_0000	Dunmanus Bay		CW2	At least Good	No		Preserve	3
IE_WE_130_0000	Aughinish Bay		CW8	At least Good	No		Preserve	3
IE_WE_200_0100	Lettermullen Pool		CW10	At least Good	No		Preserve	3
IE_WE_420_0200	Cartoon Lough, Killala Bay		CW10	At least Good	No		Preserve	3
IE_WE_460_0200	Portavaud East, Ballysadare Bay		CW10	At least Good	No		Preserve	3
IE_SW_050_0000	Outer Cork Harbour		CW5	High	No		Preserve	3
IE_SW_180_0000	Berehaven		CW5	Poor	No		Restore to at least Good by 2015	4
IE_NW_085_0000	Killybegs Harbour	Yes	CW8	Less than Good	Yes		Achieve at least GEP	GEP
IE_SE_045_0000	Rosslare Harbour	Yes	CW5	Less than Good	Yes		Achieve at least GEP	GEP
IE_SW_060_0000	Cork Harbour	Yes	CW8	Less than Good	Yes		Achieve at least GEP	GEP
IE_SH_050_0000	Inner Tralee Bay		CW8	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A

Table 10.1 (continued): Coastal water bodies and predicted default objectives to help prioritise the application of measures to achieve these objectives

Water Body Code	Name	pHMWB	Type	Overall Risk expressed as likely Morphological Status Class	At Risk from Other Factors	SAC / SPA Present - Favorable Conservation Status	Objectives - Morphological Status	Priority - Morphological Status
IE_SW_040_0000	Ballycotton Bay		CW5	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_090_0000	Dublin Bay		CW5	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_060_0000	Malahide Bay		CW8	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NB_040_0000	Outer Dundalk Bay		CW5	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_120_0000	Tramore Back Strand		CW8	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_100_0000	Outer Galway Bay		CW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_140_0000	Dungarvan Harbour		CW5	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_470_0000	Sligo Harbour		CW8	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_010_0000	Southwestern Irish Sea (HAs 11;12)		CW5	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_040_0000	Wexford Harbour		CW8	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
GBNIIE6NB030	Carlingford Lough (NB_030_0000)		CW8	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_010_0000	Boyne Estuary Plume Zone		CW5	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
GBNIIE6NW250	Lough Foyle (NW_250_0000)		CW8	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_100_0000	Southwestern Irish Sea - Killiney Bay (HA10)		CW5	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_190_0000	Outer Kenmare River		CW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_020_0000	Bundoran Bay		CW5	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_200_0000	Mulroy Bay Broadwater		CW8	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_210_0000	Mulroy Bay Northwater		CW8	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_100_0400	Clogheen Strand		CW10	*At least Good*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_110_0000	Tramore Bay		CW5	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_140_0000	Southwestern Irish Sea - Brittas Bay (HA 10)		CW6	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_240_0000	Dingle Harbour		CW5	Good	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
GBNIIE6NB010	Portstewart Bay		CW2	At least Good	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
GBNIIE6NB020	Mourne Coast		CW5	At least Good	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_160_0000	Inner Galway Bay South		CW5	At least Good	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_190_0000	Casla Bay		CW5	High	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A

Table 10.2: Transitional water bodies and predicted default objectives to help prioritise the application of measures to achieve these objectives

Water Body Code	Name	pHMWB	Type	Overall Risk expressed as likely Morphological Status Class	At Risk from Other Factors	SAC / SPA Present - Favorable Conservation Status	Actions - Morphological Status	Priority - Morphological Status
IE_WE_160_0800	Dunbulcaun Bay		TW2	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SE_140_0200	Brickey Estuary		TW2	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_190_0200	Kilmakilloge Harbour		TW2	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_0200	Camus Bay		TW2	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_190_0300	Inner Kenmare River		TW2	Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_050_0100	Inner Donegal Bay		TW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_160_0200	Gweedore Estuary		TW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_020_0400	Lackaroe (Glendine Estuary)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_110_0100	Kilkeran Lake		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_140_0200	Lissagriffin Lake		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_160_0100	Farranamagh Lough		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_170_0500	Oranmore Bay		TW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_480_0100	Drumcliff Estuary		TW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_NW_110_0100	Owenea Estuary		TW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SW_190_0100	Ardgroom		TW2	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_020_0100	Loch Mor, Inis Oirr		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_030_0100	Port na Cora lochs, Inis Meain		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_040_0100	Loch na gCadhan, Inis Meain		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_050_0100	Loch an tSaile, Arainn		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_055_0100	Baile an Duin Lagoon		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_060_0100	Loch an Chara, Arainn		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_070_0100	Loch Phort Chorruch, Arainn		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_080_0100	Loch Dearg, Arainn		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_090_0100	Loch Amurvy, Arainn		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_110_0100	Muckinish Lough		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_120_0100	Murree Lough		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_140_0100	Aughinish Lagoon		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_140_0200	Carrownahallia Lagoon, Aughinish		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_150_0100	Rossalia Lagoon		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_160_0200	Bridge Lough, Knockakilleen		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_160_0300	Loughaungreena (Doorus Loughs)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_160_0400	Lough Fadda (Doorus Loughs)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_160_0500	Lough Namona (Doorus Loughs)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_170_0100	Mweeloon Pool South		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_170_0150	Mweeloon Pool North		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_170_0200	Loughaunascalia, Ardfry Point		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_170_0400	Turreen Lough (Rinville West)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_0300	Loch Fhada Upper Pools		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_0400	Loch an Ghadai		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_0500	Loch Fhada		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_0800	Loch Cara Fionnla		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_1000	Loch Doire Bhanbh (Derravonniff)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_200_1200	Loch Conaortha (L. Aconeera)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_220_0100	Lough an Mhuilinn (Mill Lough)		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_240_0100	Ballyconneely Lough		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_260_0100	Loch an tSaile (Lough Athola), Mannin Bay		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_280_0100	Lough B≤ Finne, Inishbofin		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_320_0100	Corragaun Lough		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_330_0100	Roonagh Lough		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_WE_460_0400	Tanrego Intake		TW6	At least Good	No	TBC	Restore to High if required by FCS	1 or 3
IE_SH_040_0100	Lough Gill		TW6	High	No	TBC	Preserve	2
IE_SE_090_0100	Corock Estuary		TW2	High	No	TBC	Preserve	2
IE_NW_180_0100	Loch O Dheas, Tory Island		TW6	High	No	TBC	Preserve	2
IE_SW_170_0400	Glengarriff Harbour		TW2	High	No	TBC	Preserve	2
IE_NW_160_0100	Loch Chionn Caslach (Kincas L.)		TW6	High	No	TBC	Preserve	2
IE_NW_140_0100	Maghery Lough		TW6	High	No	TBC	Preserve	2
IE_SH_050_0200	Blennerville Lake East		TW6	High	No	TBC	Preserve	2
IE_SH_050_0300	Blennerville Lake West		TW6	High	No	TBC	Preserve	2
IE_SH_060_0400	Poulaweala Lough / Quayfield Lough		TW6	High	No	TBC	Preserve	2
IE_SH_080_0100	Doonbeg Estuary		TW2	High	No	TBC	Preserve	2
IE_NW_220_0400	Crana Estuary		TW2	High	No	TBC	Preserve	2
GBNIIE5NB030010	Newry Estuary (NB_030_0100)		TW2	High	No	TBC	Preserve	2
IE_NW_200_0200	Carrick Beg Lough (South)		TW6	High	No		Preserve	2
IE_SH_110_0100	Aille Clare Estuary		TW2	High	No		Preserve	2
IE_SW_070_0100	Oysterhaven		TW2	High	No		Preserve	2
IE_SW_170_0500	Adrigole Harbour		TW2	High	No		Preserve	2
IE_WE_440_0100	Easky Estuary		TW2	High	No		Preserve	2
IE_NW_160_0500	Meenaclady		TW2	High	No	TBC	Preserve	2
IE_WE_200_1100	Loch an tSaile, North of Camus Bay		TW6	High	No	TBC	Preserve	2
IE_NW_040_0100	Durnesh Lough		TW6	High	No	TBC	Preserve	2
IE_NW_160_0300	Moorlagh		TW6	High	No	TBC	Preserve	2
IE_NW_120_0100	Gweebarra Estuary		TW2	High	No	TBC	Preserve	2
IE_WE_200_0600	Loch Tanai		TW6	High	No	TBC	Preserve	2

Table 10.2 (continued): Transitional water bodies and predicted default objectives to help prioritise the application of measures to achieve these objectives

Water Body Code	Name	pHMWB	Type	Overall Risk expressed as likely Morphological Status Class	At Risk from Other Factors	SAC / SPA Present - Favorable Conservation Status	Actions - Morphological Status	Priority - Morphological Status
IE_WE_200_0700	Loch an Aibhinn, Camus Bay		TW6	High	No	TBC	Preserve	2
IE_NW_060_0100	Eany Water Estuary		TW2	At least Good	No		Preserve	3
IE_SW_060_0100	Rostellan Lake		TW6	At least Good	No		Preserve	3
IE_SW_060_0200	Cuskinny Lake		TW6	At least Good	No		Preserve	3
IE_SW_060_1100	Lough Beg / Curraghbinny		TW6	At least Good	No		Preserve	3
IE_SW_070_0200	Oysterhaven Lake, Clashroe		TW6	At least Good	No		Preserve	3
IE_SW_150_0100	Reen Point Pool		TW6	At least Good	No		Preserve	3
IE_SW_170_0200	Kilmore Lake, Whiddy Island		TW6	At least Good	No		Preserve	3
IE_SW_170_0300	Reenydonagan Lough		TW6	At least Good	No		Preserve	3
IE_NB_040_0600	Corstown Lagoon		TW6	At least Good	No		Preserve	3
IE_SE_130_0100	Mahon Estuary		TW2	At least Good	No		Preserve	3
IE_WE_190_0200	Lough Faddacrussan		TW6	At least Good	No		Preserve	3
IE_WE_210_0100	Loch an Chaorain (L. Keeraun)		TW6	At least Good	No		Preserve	3
IE_WE_290_0100	Lough Anillaun, Cleggan Bay		TW6	At least Good	No		Preserve	3
IE_WE_370_0100	Dooniver Loughs		TW6	At least Good	No		Preserve	3
IE_WE_420_0100	Cloonaghmore Estuary		TW2	At least Good	No		Preserve	3
IE_WE_460_0100	Portavaud West, Ballysadare Bay		TW6	At least Good	No		Preserve	3
IE_NB_030_0200	Carlingford Lagoons (Greenore Gold Course Lagoons)		TW6	At least Good	No		Preserve	3
IE_WE_180_0100	Spiddal Estuary		TW2	Moderate	No		Restore to at least Good by 2015	4
IE_EA_060_0100	Broadmeadow Water	Y	TW6	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SE_100_0200	New Ross Port	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SH_060_0100	Cashen	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SH_060_0200	Upper Feale Estuary	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SH_060_0350	Foynes Harbour	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SH_060_0900	Limerick Dock	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_EA_090_0300	Liffey Estuary Lower	Y	TW2	Less than Good	Yes		Achieve at least GEP	GEP
IE_SW_060_0900	Lee (Cork) Estuary Lower	Y	TW2	Less than Good	Yes		Achieve at least GEP	GEP
IE_SE_100_0500	Lower Suir Estuary / Waterford Harbour	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SW_060_0750	Lough Mahon	Y	TW2	Less than Good	Yes	TBC	Achieve at least GEP	GEP
IE_SE_040_0100	North Slob Channels		TW6	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_060_0100	Lady's Island Lake		TW6	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_050_0100	Rogerstown Estuary		TW2	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_080_0100	Mayne Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_080_0200	Ballyteige Channels		TW6	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_080_0100	Bridgetown Estuary		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_030_0100	Womanagh Estuary		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NB_040_0400	Fane Estuary		TW2	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NB_040_0100	Inner Dundalk Bay		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NB_040_0300	Ballymascanlan Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_230_0200	Castlemaine Harbour		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_230_0100	Cromane		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_160_0600	Lough Sallagh (Doorus Loughs)		TW6	*Good*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_170_0700	Corrib Estuary		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_160_0100	Kinvarra Bay		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_140_0100	Colligan Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_470_0100	Garavoge Estuary		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_400_0200	Sruwaddacon Bay		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_390_0100	Tullaghan Bay		TW2	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_220_0200	Blanket Nook Lough		TW6	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_220_0100	Swilly Estuary		TW2	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SH_060_0300	Lower Shannon Estuary		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SH_060_0800	Upper Shannon Estuary		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SH_060_1100	Fergus Estuary		TW2	*Good*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SH_060_1200	Clonderalaw Bay		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_010_0100	Boyne Estuary		TW2	Bad	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_100_0100	Clonakilty Harbour		TW2	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_120_0100	Kilcoole Marsh		TW6	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
GBNIIE5NW250010	Foyle and Faughan Estuaries (NW_250_0100)		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A

Table 10.2 (continued): Transitional water bodies and predicted default objectives to help prioritise the application of measures to achieve these objectives

Water Body Code	Name	pHMWB	Type	Overall Risk expressed as likely Morphological Status Class	At Risk from Other Factors	SAC / SPA Present - Favorable Conservation Status	Actions - Morphological Status	Priority - Morphological Status
IE_SE_070_0100	Tacumshin Lake		TW6	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_EA_130_0100	Broad Lough		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_NW_220_0300	Inch Lough		TW6	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_020_0100	Owenavorragh Estuary		TW2	Bad	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_NB_040_0500	Glyde Estuary		TW2	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_NW_010_0100	Duff Estuary		TW2	Moderate	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_110_0200	Rosscarbery Harbour		TW6	Moderate	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_EA_090_0100	North Bull Island		TW6	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_EA_090_0200	Tolka Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_100_0250	Barrow Nore Estuary Upper		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_100_0550	Middle Suir Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SH_060_0700	Maigue Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_020_0100	Lower Blackwater M Estuary / Youghal Harbour		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_EA_090_0400	Liffey Estuary Upper		TW2	Less than Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_EA_150_0100	Avoca Estuary		TW2	Less than Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_0950	Lee (Cork) Estuary Upper		TW2	Less than Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_080_0100	Lower Bandon Estuary		TW2	Less than Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_NB_040_0200	Castletown Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_040_0200	Lower Slaney Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SH_050_0100	Lee K Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_0400	Owenacurra Estuary		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_0700	Lough Mahon (Harper's Island)		TW2	Less than Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_0800	Glashaboy Estuary		TW2	Less than Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_EA_110_0100	Dargle Estuary		TW2	Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_190_0500	Drongawn Lough, Sneem		TW6	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_1200	Owenboy Estuary		TW2	Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_100_0100	Barrow Suir Nore Estuary (Waterford Harbour Lower)		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_WE_350_0100	Westport Bay		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_WE_350_0200	Newport Bay		TW2	Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_040_0300	Upper Slaney Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_100_0300	Upper Barrow Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_100_0600	Upper Suir Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SH_060_0600	Deel Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SH_090_0100	Lough Donnell		TW6	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_020_0500	Upper Blackwater M Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_0300	North Channel Great Island		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_060_0600	Slatty Bridge, Fota Island		TW6	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_WE_420_0300	Moy Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_080_0300	Upper Bandon Estuary		TW2	At least Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_NW_020_0100	Drowes Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_NW_190_0100	Lackagh Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SE_100_0400	Nore Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_130_0100	Ilen Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_190_0400	Blackwater K Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_190_0600	Sneem Harbour		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_WE_460_0300	Ballysadare Estuary		TW2	At least Good	Yes	TBC	POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_110_0300	Glandore Harbour		TW2	At least Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_SW_220_0100	Ferta		TW2	At least Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A
IE_WE_230_0100	Roundstone Bay		TW2	At least Good	Yes		POMS required for Other Factors. Address morphology in 2^{nd} RBMP	N/A

Table 10.2 (continued): Transitional water bodies and predicted default objectives to help prioritise the application of measures to achieve these objectives

Water Body Code	Name	pHMWB	Type	Overall Risk expressed as likely Morphological Status Class	At Risk from Other Factors	SAC / SPA Present - Favorable Conservation Status	Actions - Morphological Status	Priority - Morphological Status
IE_WE_270_0100	Clifden Bay		TW2	At least Good	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_170_0300	Ardfry Oyster Pool		TW6	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_170_0600	Renmore Lough, Galway City		TW6	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_310_0100	Erriff Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_190_0100	Casla Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SH_060_1000	Shannon Airport Lagoon		TW6	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NB_030_0250	Shilties Lough		TW6	*High*	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SE_040_0400	South Slob Channel		TW6	*High*	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_170_0100	Inner Bantry Bay		TW2	*High*	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_090_0100	Teelin Bay		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_NW_030_0100	Erne Estuary		TW2	*High*	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_410_0100	Bunatrahir Bay		TW2	High	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SH_100_0100	Inagh Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_SW_090_0200	Argideen Estuary		TW2	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_WE_350_0300	Furnace Lough		TW6	High	Yes	TBC	POMS required for Other Factors. Address morphology in 2nd RBMP	N/A
IE_EA_030_0100	Nanny Estuary		TW2	High	Yes		POMS required for Other Factors. Address morphology in 2nd RBMP	N/A

10.4.3 Identification of Appropriate Measures

Following the prioritisation of TraC water bodies (Section 10.3.2), the most appropriate measures required to achieve the relevant objectives need to be determined.

Once prioritised, these water bodies can be assessed for the pressures causing the greatest risk and preventing a water body achieving its required status. From this information, the possible measures or mitigation can be selected and prioritised from the good practice information. These measures can then be assessed to ensure beneficial changes to the water body and to ensure they are technically feasible and cost effective.

Figure 10.3 below outlines the various steps required to identify the most appropriate measures for each priority water body with the aim to either preserve the existing status or restore morphological conditions to achieve a higher status class. The application of Steps 1 to 8 is summarised below. To help demonstrate this process, four examples of TraC water bodies are detailed for each objective:

- Priority 1: Restore high morphological status in any TraC water bodies where ‘protected area’ favourable conditions require high status
  - Example: Inner Kenmare River (SWRBD)
- Priority 2: Preserve high morphological status in existing high status TraC water bodies by managing existing pressures and controlling new development
  - Example: Glengariff Harbour (SWRBD)
- Priority 3: Preserve good morphological status in existing good status TraC water bodies by managing existing pressures and controlling new development
  - Example: Outer Bantry Bay (SWRBD)
- Priority 4: Restore good morphological status in any TraC water bodies that would otherwise be of good status (this implies that all other water quality elements are at least good status)
  - Example: Berehaven (SWRBD)

It is important to note that, to facilitate reporting, the risk assessment results of further characterisation are documented here as ‘status class’, e.g. where TraC-MImAS has indicated no risk to HES, the status class is assumed to be HES, and where TraC-MImAS assessment was not undertaken, Tables 10.1 and 10.2 tabulate status as ‘At

Least Good' or 'Less than Good' based on the results of the initial risk assessments (refer to assumptions made in Section 6.3 of this report).

Further guidance will be required from the relevant authorities in order to assist this decision making process. Once an appropriate measure is proposed this must then be subjected to the appropriate existing assessment and regulatory mechanism to ensure that they are appropriate and morphologically beneficial within the wider context.

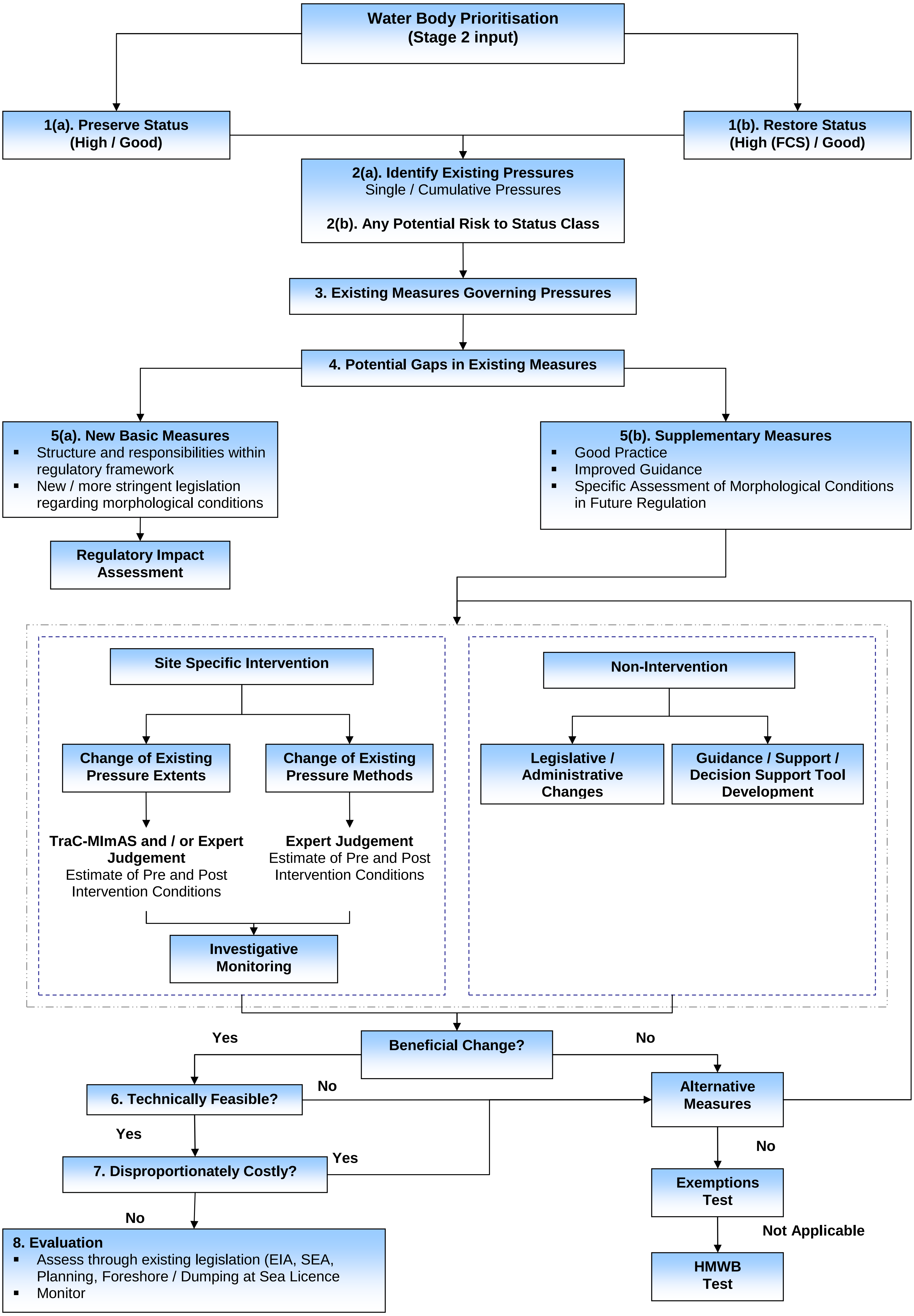


Figure 10.3: Identification of Appropriate Morphology Measures for TraC water bodies

Step 1. Water Body Objectives

The preservation of high or good status can be achieved through the control of both existing and future developments and activities, the latter of which is discussed further in Chapter 11. Changes in status are likely to occur from two potential sources; development, being the most significant, and external or natural changes. The latter source may only be detected by monitoring. Temporary deterioration in status is permitted under the WFD when this is the result of circumstances of natural cause or ***force majeure*** which are exceptional or could not reasonably have been foreseen (Article 4(6)).

Restoration of a water body to high or good status can require the removal and / or mitigation of existing pressures.

Step 2. Existing Pressures

This step requires the identification of the existing pressures impacting on a water body, and, of particular relevance to the objective of no deterioration. Any potential risks posed by these pressures to the existing status class should be highlighted.

The Marine Morphology PoMs study provides information on the types, extents and locations of morphological pressures estimating the cumulative impacts where multiple pressures are present. From this information, it can be established if the pressures impact significantly on the intertidal or subtidal zones, or contribute to a single significant pressure or cumulative effect.

For those water bodies that require restorative measures, the risk assessments using TraC-MImAS, completed as part of the further characterisation of risk (Chapter 6), can indicate the most significant pressures impacting on a water body (impact rating and potential zone of impact) thereby focusing the review of appropriate measures. With regard to those water bodies which require preservation of morphological status, TraC-MImAS can help identify potential risks to status class by providing an indication of the available system capacity currently used by physical modifications. On reviewing pressure extents identified for this study, it is important to consider the confidence in data used (this is expressed in Appendix 6-3 by the availability of coastal images when digitising / assessing pressures).

Examples are provided as follows:

Inner Kenmare River (Priority 1)

The predicted objective for this water body is to achieve HES. For the purpose of this example, it is assumed that the Kenmare River SAC requires high ecological status to achieve FCS.

The existing pressures identified for Inner Kenmare River are as follows:

- Other disturbances to seabed (aquaculture dredging)
- Flow and sediment manipulation structures
- Piled structures
- Shoreline reinforcement

The most significant pressure identified is considered to be that associated with the areas licensed for aquaculture dredging, the extent of which indicates a failure of HES as well as a risk to the maintenance of GES.

Detailed assessment of the potential impact of aquaculture practices on morphology is beyond the scope of this study. Therefore the risk identified here is only indicative based on the assumption of shellfish dredged areas. Consequently, the risk predicted for water bodies subject to these practices may be high than the actual risk posed. Prior to further assessment and prioritisation of appropriate measures for this water body the exact extents and intensity of this activity should be confirmed with the relevant authorities as a minimum.

Glengariff Harbour (Priority 2)

The default objective predicted for this water body is to maintain HES.

The further characterisation of risk to this water body estimated that the type and extent of existing pressures do not currently impact significantly on morphological conditions and therefore indicate its potential to achieve HES. The pressures identified are as follows:

- High impact land claim (associated with the harbour itself)
- Flow and sediment manipulation structures
- Piled structures
- Shoreline reinforcement

On review of the pressure footprints, the results of further characterisation indicate a significant risk to the maintenance of the existing morphological condition, and therefore a risk to HES. Prior to further validation via monitoring etc, the extent of the reclaimed intertidal area indicates that 4.2% of the intertidal area's system capacity is used (5% is the boundary for GES), i.e. its ability to withstand further morphological change without adversely affecting ecology is significantly reduced by existing pressures. It can therefore be concluded that the management of future development and activities associated with this harbour is of primary importance in preventing deterioration of status.

Outer Bantry Bay (Priority 3)

The default objective predicted for this water body is to maintain GES. Outer Bantry Bay is not currently associated with the Natura 2000 network.

The pressures identified for Outer Bantry Bay are as follows:

- Low impact dredging (maintenance)
- Other disturbances to seabed (aquaculture dredging)
- Disposal of dredgings
- Flow and sediment manipulation structures
- Piled structures
- Shoreline reinforcement

The most significant pressure is associated with the maintenance of shipping channels, the extent of which indicates a significant contribution to the failure of HES. The extent of pressures identified does not currently indicate a significant risk to the maintenance of GES based on the Morphological Condition Limits (MCLs).

Berehaven (Priority 4)

The default objective predicted for Berehaven is to restore status to at least GES by 2015.

The pressures identified for this water body are as follows:

- Land claim
- Dredging
- Other disturbances to seabed (aquaculture dredging)
- Flow and sediment manipulation structures
- Piled structures
- Shoreline reinforcement

The most significant pressures identified as impacting on this water body are low impact dredging associated with maintenance of the shipping channel and potential shellfish dredging, both of which contribute to the potential failure of GES. As noted above, the potential impact of aquaculture practices on morphology is beyond the scope of this study, and the risk associated with these practices are indicative and based on estimated pressure extents. Prior to further assessment and prioritisation of appropriate measures for this water body the exact extents and intensity of this activity should be confirmed with the relevant authorities as a minimum.

Step 3. Existing Measures

The pressure analysis described above identifies the morphological pressures which have or can potentially lead to a water body failing its required objective. This can then help focus the identification of existing measures controlling / mitigating the current operations.

The measures currently in place to control the existing operations relating to these pressures can generally be categorised as follows:

- Planning controls
- Environmental impact thresholds and controls
- Ministerial licenses and leases
- Aquaculture production controls (generally focused on water pollution)
- Good practice measures (mitigation already in place)

As identified in Section 10.2, potential gaps associated with the existing mechanisms may limit adequate consideration of the impact on morphological conditions.

The following chapter, Chapter 11, specifically outlines the gaps identified in the existing regulatory framework for Irish TraC waters and makes recommendations for the enhancement of this framework.

With regard to mitigation measures, various EISs relating to physical alterations of TraC waters were reviewed for this study (Appendix 3-2). This register of EISs can, for a limited number of water bodies, identify where the potential impacts of physical alterations have been considered in terms of baseline assessments and proposed mitigation measures.

On review of potential measures for a specific water body, those currently mitigating the pressures on this water body will need to be identified to enable a specific review of effectiveness. The effectiveness of a measure should be broken down into two aspects:

- **Morphological / biological effectiveness:** Existing morphology / biology monitoring programmes identified in Chapter 4, the review of TraC-MImAS in Chapter 5, and the Good Practice Review in Chapter 7 can contribute to the assessment of this relationship. However, as emphasised throughout this report, a national programme clarifying the relationship between morphology and ecology is fundamental to the appropriate assessment of impact, objectives and measures for TraC water bodies.
- **Timescales:** This requires an estimate of the time when the effectiveness of the measure is expected to be fully observed i.e. will the measure contribute to the achievement of the relevant objective by 2015? This can only be considered on a site-by-site basis. With the exception of regulatory measures, it is considered that most morphology related measures will deliver results gradually over time. Upstream measures such as a fish pass may demonstrate benefits within a short space of time; however, measures such as reducing extent of dredging or culverts in breakwaters may not be realised for many years.

Step 4. Potential Gaps in Existing Measures

Using information provided by this study a review of existing measures will help identify what new / supplementary measures, if any, can be taken to control, mitigate, or remove these pressures, with the aim of achieving the required objective. The following examples are used to illustrate this:

Inner Kenmare River: The most significant pressure identified for this water body is that associated with the dredging of shellfish, a detailed review of which is beyond the scope of this study. It is considered that very few TraC water bodies will require improvement measures to increase the status of a water body from good to high in order to meet FCS. However, such a situation will require a very detailed site specific assessment guided by the NPWS. Legacy issues will require consideration, for example, aquaculture activities may pre-date the designation of Natura 2000 sites and therefore may contribute to the structure and function of its status.

Glengariff Harbour: This water body is required to maintain HES, but existing pressures, specifically land claim, within this water body are currently indicating a significant risk to this objective. Prior to the reclamation, this development would have undergone appropriate assessment as required by the Planning and Foreshore Acts. It is assumed that if potentially significant environmental effects were identified during this assessment, then an overriding pubic interest or justification of development would have been concluded at the time. The details of the development are not known, but the mitigation options for such a pressure (land claim) were likely to have been restricted to the assessment of alternative locations. The use of piled supports is an alternative design option, but this can restrict the development and future use of the new land. The measures relevant to such a development are considered to have been appropriate; however, to prevent further deterioration of this harbour the regulation of future development and operations in the harbour is fundamental. Those relevant gaps identified in the existing regulatory framework are outlined in Sections 10.3 and Chapter 11.

Outer Bantry Bay, which also requires the maintenance of status (GES), is at most risk from the operation and maintenance of shipping channels. Within this water body is the Whiddy Island Oil Terminal, which in contrast to the small harbours of Inner Bantry Bay and Glengariff, can facilitate larger vessels. Harbours and terminals such as this are legally required to ensure safe navigation.

A review of the maintenance dredging operations as well as future proposals for the harbours and oil terminal is key to identifying any specific measures to mitigation existing activities. Similar to Glengariff Harbour, the control of future operations is necessary for the maintenance of status.

Berehaven is required to improve its status to GES, therefore, it can be assumed that the existing measures are not sufficient to achieve the WFD objective of GES. New measures should be focused on the specific pressures identified via reference to the Good Practice Review of Chapter 7.

Step 5. New Basic / Supplementary Measures

The implementation, in full, of basic measures is of primary importance to the maintenance of ecological status. Any significant gaps in measures identified by the previous steps must be addressed to enable achievement of the relevant objectives and therefore compliance with the WFD. For those water bodies requiring restoration the implementation of supplementary measures will initially be required to achieve the required status.

New Basic Measures

Any new basic measures should take the form of legislation outlining the structure and responsibilities of regulatory bodies to enhance the existing control of coastal development and activities.

New / more stringent legislation regarding morphological conditions cannot be advised at this time. Further monitoring and detailed assessment of the relationship between ecology and morphology is imperative to the refinement of the TraC-MImAS morphological condition limits or other appropriate standards for the assessment of morphological condition.

New basic measures may be subject to Regulatory Impact Assessment.

Supplementary Measures

Figure 10.3 identifies three forms of potential supplementary measures:

i. **Site specific intervention (pressure extents):** in the extreme this could involve the removal of the pressure in question, but can also include practices such as managed realignment or reducing dredging areas. The potential improvement of status may be reviewed through the use of TraC-MImAS. However, this tool cannot contribute to the assessment of timescales (Step3). With regard to mitigating proposed pressures, the feasibility of alternative locations and timescales should be investigated.

ii. **Site specific intervention (pressure methods):** these measures do not entail a change in the footprint of a pressure as measured by TraC-MImAS, but a change in the operations. Possible measures can include an alternative method of operating the pressure which may result in a reduced ecological impact. The frequency of activities can be taken into account, as they may be seasonal or annual, and further study or investigation may indicate that this could be carried out less frequently. Benefits of these measures cannot be screened by TraC-MImAS; however, ecological improvement may be detected through monitoring.

The effectiveness of such site specific intervention measures is summarised in the Good Practice Guide (Chapter 7).

iii. **Non intervention methods**, such as regulation, more comprehensive / stringent guidelines, awareness programmes and support systems, including management and ICZM. Expert judgement may be required to determine the benefit of these measures. This can be assisted by the various case studies addressed in Chapter 7 of this report.

As recommended in Chapter 7, in reviewing generic Good Practice, it is important to emphasise that measures, such as those outlined above, which have proven successful in one location may not be directly applicable in other environments. Therefore, in deciding the most appropriate measures, site specific investigations and designs should be considered in the context of a wider strategy (RBMPs).

Specific options for the mitigation and / or removal of pressures are recommended in Chapter 7. With regard to the future control of development and activities, Chapter 11 assesses the existing regulatory framework and makes recommendations for supplementary measures to improve this process.

Step 6. Technical Feasibility

As indicated in Figures 7.2 and 7.3 of Chapter 7, the question that should be asked when considering feasibility is 'are the measures technically feasible given ***site specific considerations***?'

Measures such as site specific intervention measures can be used to address specific pressures; however, in practice their application may not be feasible. The marine morphology Good Practice Review documents the feasibility of some measures through the review of various case studies. Links to practical guidance such as the 'Development of hydro-morphological improvement targets for surface water bodies' (SNIFFER, 2005) are also provided. This SNIFFER study outlines various measures to address specific pressures on TraC waters, indicating the feasibility of these measures as well as their ability to mitigate the pressure and result in a beneficial change.

The feasibility of morphology measures should also consider local acceptability and enforceability (responsible organisations and mechanisms for delivery) when prioritising measures. Local acceptability of stakeholders is of particular relevance to TraC morphology due to the international importance of these water bodies (habitat protection, international competitiveness of ports / navigation and food export sectors). With regard to enforceability, various gaps in the existing framework were identified in Section 10.2 – 10.4. The recommendations made in relation to these gaps are measures in themselves and should be addressed to facilitate the effective assessment of other measures.

If the measures are not considered feasible, alternatives should then be assessed. If suitable measures cannot be identified in order to achieve the required objective by 2015, then a review of exemptions permitted under Article 4 of the WFD should be undertaken.

If the conditions of the exemptions cannot be met a water body may need to be considered as heavily modified, to achieve at least good ecological potential by 2015.

Step 7. Cost

The costing of individual measures based on the information available to date has proved difficult. However, the cost effectiveness of implementing morphological pressures is addressed, where possible, in Chapter 7. As noted in the introduction those measures achievable at minimum costs typically include the development or application of codes of practice and better enforcement of (often existing) local regulation.

Measures prohibiting certain activities or work methods, such as dredging, may be shown to be disproportionately costly particularly when considered in the context of the wider strategy.

In addition to the financial cost of implementing measures and as an addition to the consideration of local acceptability (Step 6), the socio-economic aspects should be addressed as these measures may pose restrictions to particular sectors. The SEA process when applied to the RBMPs should adequately address these costs and / or potential implications.

Similar to Step 6, if the identified measures are disproportionately expensive alternative measures should be assessed.

Step 8. Evaluation

Supplementary measures will need to be evaluated on a local basis and any 'physical actions' would be subject to evaluation under existing development and regulatory mechanisms (SEA, EIA, licensing, planning) as relevant. Evaluation of all proposed measures should include strategic and cumulative appraisal to ensure that correcting one issue does not significantly affect other elements of the water body in question, as well as neighbouring water bodies. The River Basin Management Plans and associated SEAs should consider the strategic value of proposed measures.

10.5 Overall Conclusions

Within the existing legislative framework concerning TraC waters, morphology can be adequately assessed at a project or strategic level. However, it is concluded that currently there is not adequate scope for morphology to be highlighted as a potentially significant environmental aspect or interaction i.e. for morphology to act as a ‘trigger’ for further environmental assessment.

Where good and high status exist there is a priority to maintain these through the control of existing operations and future development. The Marine Morphology Study and TraC-MImAS tool can help determine the available capacity of the water bodies to further morphological change, and support the control of proposals within the existing legislative structure to prevent deterioration of status. Morphology can be affected on a wider spatial scale than Local Authority and RMBP or even national boundaries, and will therefore benefit from Integrated Coastal Zone Management and effective assessment of strategic and cumulative effects to ensure preservation of status.

Where there are existing pressures causing a water body to be at risk or reaching its required morphological status, restoration may be required. Restoration measures should be compared against current good practice and against technical feasibility and excessive costs. Once selected, the measures should be assessed through the current legislative mechanisms, which should now include morphological assessment.

The appropriate consideration of the recommendations relating to existing and new basic and supplementary measures, as summarised in Section 10.4, is fundamental to the effective application of the methods recommended for water body prioritisation and identification of measures (Figures 10.2 and 10.3).

In addition to the requirement for a structured legislative framework for TraC waters, Section 10.5.1 summarises the information required of these methods (Figures 10.2 and 10.3) to determine and achieve their objective of prioritisation. In summary, additional monitoring and appraisal of the pressures, as outlined in Chapters 9 and 3 respectively, should be undertaken to develop adequate baseline information on the morphology of TraC water bodies as well as evidence-based thresholds for the consideration of risk (refinement of MCLs).

With regard to the consideration of cumulative impacts, sectoral guidance such as that provided by the NRA for road construction projects in Ireland would be of significant benefit to the appropriate assessment and sustainable management of TraC water bodies. The SEA directive and the RBMPs should provide for such consideration of plans, programmes and their cumulative impacts.

11 RECOMMENDED REGULATORY DECISION SUPPORT METHODOLOGY FOR FUTURE USE

11.1 Introduction....1
11.1.1 Planning and Environmental Impact Assessment....2
11.1.2 The WFD and Physical Modifications....5
11.2 Decision Support for the Regulation of Physical Modifications....9
11.2.1 Regulatory Process for the Authorisation of Developments consisting of Physical Modifications....11
11.2.2 Screening....13
11.2.3 Pre-application Discussions....14
11.2.4 Scoping....16
11.2.5 Receipt of Application....16
11.3 Worked Example: Inner Bantry Bay Proposed Harbour Development 18
11.3.1 Screening....20
11.3.2 Pre-application Discussion....21
11.3.3 Receipt of Application....30
11.4 Further Development....30
11.4.1 Base Data and TraC-MImAS....30
11.4.2 Water Body Scaling and Single Activity Limits – Thresholds for Screening....34

The purpose of this chapter is to outline how the deliverables of the Marine Morphology PoMS Study can assist the regulation of future physical modifications of Ireland's TraC waters with the aim of achieving WFD objectives. Following on from Chapter 10, the existing regulatory framework of relevance to estuarine and coastal modifications is summarised. Section 11.2 of this chapter then describes how the Marine Morphology Study can support the regulatory process, by firstly summarising the key elements of this study, then recommending the relevant stages at which the Marine Morphology Study and TraC-MImAS can compliment this system. Following a review of the relevant stages, a summary is provided of recommendations as to how these stages can be supplemented to support the regulation of alterations to morphology. Using an example of a harbour development proposal for Inner Bantry Harbour; the existing regulatory system currently applicable to such a development, including that required by the WFD, is outlined to demonstrate how the findings of this study can contribute.

Appendix 11-1 summarises the proposed measures identified within Chapters 10 and 11 as relevant for marine morphology within the template required for reporting to the National PoMS Co-ordination Group

For the purpose of this chapter, those environmentally sensitive areas likely to be affected by proposed developments are referred to collectively as 'sites of conservation sensitivity'.

11.1 Introduction

11.1 Introduction

Coastal developments in Ireland are currently governed by the DEHLG, Local Authorities, DAFF, and the DCENR.

The Engineering Division of DAFF (formally DCMNR) assesses the potential environmental impacts of relevant proposals, and licences are processed by the Marine Licence Vetting Committee (MLVC) (within DAFF). DAFF is also currently responsible for coastal protection and the design of schemes proposed by private interests or local authorities is examined by Department engineers. It is important to note that, as summarised in Section 10.2.1 various responsibilities are currently being transferred to DEHLG.

For the purpose of this chapter, the various regulatory bodies for which guidance and approval are required for estuarine and coastal developments are referred to collectively as 'consent authorities'.

11.1.1 Planning and Environmental Impact Assessment

The current planning system within Ireland is based on local planning authorities, consisting of County Councils, City Councils, Borough Councils and Town Councils, all of which are responsible for granting planning permission in the area to which they relate. An Bord Pleanála considers any appeals of planning decisions made by local planning authorities and as of 2001 is responsible for assessing and determining major local authority infrastructural developments.

The planning laws in Ireland consist of the Planning and Development Acts 2000 to 2006, and the Planning and Development Regulations 2001 to 2007. DEHLG provides the legislative framework and policy guidance for Ireland's planning system. Subject to the scale of a proposed project, an application for planning is accompanied by an EIS.

Where a development is proposed to be carried out by a local authority that is also the planning authority, planning applications and any EIS prepared by the local authority must be submitted to An Bord Pleanála for approval. Other parties seeking planning permission within the local authority jurisdiction apply to the relevant local authority. However, in certain circumstances, in accordance with the Planning and Development Regulations 2006, developers of proposed infrastructure are no longer obliged to secure planning permission from local authorities before going to An Bord Pleanála. These exceptions are for strategic infrastructure development which can generally be described as development which is of strategic economic or social importance to the State or a region. It also includes development which will contribute significantly to the fulfilment of any of the objectives of the National Spatial Strategy or any regional planning guidelines for an area, or which would have significant effects on the area of more than one planning authority.

The Foreshore Acts, 1933 to 1998, require a lease or licence to be obtained from the Minister at DAFF for undertaking any works or placing structures or material on, or for the occupation of, or removal of material from, State-owned foreshore. The consent of the Minister is also required for development on privately owned foreshore. The foreshore is defined in the Foreshore Act 1933 as '***the bed and shore, below the line of high water of ordinary or medium tides, of the sea and of every tidal river and tidal estuary and of every channel, creek and bay of the sea or of any such river or estuary'***, and includes the ***'land between the line of high water of ordinary or medium tides and land within the functional area of the planning authority concerned that adjoins the first-mentioned land'*** (Planning and Development Act 2000).

The General Guidance Notes issued by DAFF for the Foreshore Acts 1933 – 2003 urge applicants for a lease or licence to ***'consult the Department well in advance of finalising their proposals'***.

Developments on the foreshore may require planning permission in addition to the appropriate consent under the Foreshore Acts, and in such cases applicants are required to consult initially with the local planning authority. For foreshore developments for, on behalf of, or in partnership with a local authority where an EIS is required, applications should be made to An Bord Pleanála for approval of the proposed development (Part XV, Planning and Development Act 2000).

Similarly, in relation to dumping at sea permits, DAFF advises that prior to the submission of an application the applicant should consult with all relevant parties, particularly those likely to be affected by the project (e.g. fishermen, fish farmers, anglers, conservationists). These consultations, when carried out at an early stage in the planning of the project, 'can identify potential conflicts with other users, which may be overcome by modification of the project' (Cronin et al, 2006) (e.g. changing the location of the dump site, or dumping operations only at specified times of the year). Prior to the approval of the disposal of dredged material at sea, the Marine Institute may request further assessment of a proposal.

The EU Environmental Impact Assessment Directive (85/337/EEC as amended by 97/11/EC and 2003/35/EC) requires that certain developments be assessed for likely environmental effects before planning permission can be granted. For such developments, planning applications must be submitted with an EIS. Projects for which EIA is mandatory are listed in Annex I of the EIA Directive and those for which an EIA may be required are outlined in Annex II. In the case of Annex II projects, the EIA Directive allows Member States to choose to apply thresholds or use case by case examination, or a combination of both. Ireland transposed Annex II by setting mandatory thresholds for each of the project classes.

In 2002 the EPA published 'Guidelines for the Information to be contained in an Environmental Impact Statement'. These guidelines have a statutory basis and must be regarded by those preparing and evaluating EISs. It is unclear at present if these guidelines will be updated to reflect various elements of the WFD requirements. For example, 'Morphology' may be added to the topics specified in the EIS Regulations and EPA Guidelines. These topics are currently defined as follows:

- Human beings
- Fauna and flora
- Soil
- Water
- Air
- Climatic factors
- Landscape
- Material assets
- Inter-Relationship between the above factors

The EIA requirements under Irish planning legislation have been consolidated into Part X of the Planning and Development Act 2000, Part 10 of the Planning and Development Regulations 2001, and Schedule 5 of the Planning and Development Regulations 2001 (amended by the Planning and Development Regulations, 2005), the last of which specifies the developments and thresholds for which an EIA is required. Projects which do not exceed a specified value, area or other limit are termed 'sub-threshold' developments. Article 103 of the Planning and Development Regulations 2001 requires, for those developments that fall below the relevant EIA thresholds (sub-threshold developments) and/or are located in or on sites of conservation sensitivity, that a planning authority must request an EIS where it considers that the proposed development is likely to have significant environmental effects. The criteria governing the need for sub-threshold EIA are set out in the Third Schedule to the European Communities (EIA) (Amendment) Regulations 1999 and in Schedule 7 to the Planning and Development Regulations 2001.

Article 179 of the Planning and Development Act, 2000, specifies a procedure to be applied to certain prescribed developments that do not require EIA. These are prescribed in Part 8 of the P & D Regulations, 2001 and relate to projects by, on behalf of, or in partnership with Local Authorities.

Where there are no clear requirements for an EIA under the Regulations, the EPA (2002) advise that where ***"reasonable concerns exist that a single or very limited number of environmental topics may be adversely affected by a development proposal then an appropriate evaluation of the relevant topics may be carried out".*** This 'appropriate evaluation' should observe both the structure and methods of an EIS, and where possible ***"pre-existing standardised terms for the significance of impacts"*** should be used for this evaluation.

11.1.2 The WFD and Physical Modifications

The environmental objectives required of the WFD are prescribed in Article 4 of the Directive. The Directive recognises that under specific circumstances it may not be realistic to set 2015 as the deadline for achieving 'good status' for all water bodies by allowing (strictly conditional) derogations where alternative objectives can be set. Decisions about the use of alternative objectives must be based on the factors set out in Article 4 of the WFD, including consideration of the technical feasibility and of costs and benefits of implementing the measures which would be necessary to achieve the WFD objectives in a given water body.

Article 4 (7) of the WFD sets out the conditions under which a Member State will not be in breach of the Directive when, ***inter alia,*** failure to achieve GES/GEP or prevent the deterioration in the status of a water body is the result of "***new modifications to the physical characteristics of a water body***" or when failure to prevent deterioration between high and good status is the result of "***new sustainable human development activities***".

As introduced in Chapter 3 of the appended Literature Review (Appendix 2-1), a Common Implementation Strategy for the WFD was agreed by the EC Member States and Norway in May 2001 with the aim being to support Member States in addressing scientific, technical and practical challenges of the WFD. In December 2006 the European Water Directors endorsed a CIS policy document titled 'Exemptions to the Environmental Objectives under WFD Article 4.7', (CIS 2006(a)). This policy document notes that the **provisions of Article 4(7) are fully applicable now**. Therefore, if a proposal is found likely to threaten the achievement of the WFD objectives, the conditions of Article 4(7) will need to be demonstrated before permission is granted.

In contrast to the EIA Directive, the size of a development is not a trigger for Article 4(7). CIS (2006(a)) notes that for small projects not falling within the scope of the EIA Directive a ***"generic approach can be used in order to reduce the assessment burden".*** For those projects that do fall within the scope of the EIA Directive the information provided by such an assessment will help determine if the conditions of Article 4 (7) are met. As noted in CIS 2006(a), and endorsed by this study; ***"a joint procedure which correctly reflects the provision of EIA and WFD can be pragmatic and cost-effective".***

As with all WFD exemptions, Article 4(7) does not apply when the provisions of Articles 4(8) and 4(9) are not fulfilled, i.e. the use of exemptions is permitted only when ***"they guarantee at least the same level of protection as existing Community legislation and provided that they do not permanently exclude or compromise the achievement of the wider objectives of the WFD under Article 1 in other bodies of water within the same river basin district"*** (CIS, 2006 (a)). **Article 4(7) cannot be used as an exemption from fulfilling the legal requirements of other Directives**.
Article 4(7) only applies to new modifications or activities, and not to existing activities. In the context of such activities, other derogations may apply.

It is suggested that prior to formal clarification from Government level on the applicability of Article 4(7), both developers and consent authorities should consider the guidance of the CIS when considering if Article 4(7) applies. Particular reference should be made to Figure 11.1 below, an extract from CIS (2006(a)), which outlines how the conditions under Article 4(7) may be applied to both new modifications and new sustainable human development. It is considered appropriate for developers to continue to apply the relevant environmental assessments (EIA process), answer the questions of Article 4(7), and be proactive by identifying any potentially significant issues in terms of WFD compliance early in the regulatory process.

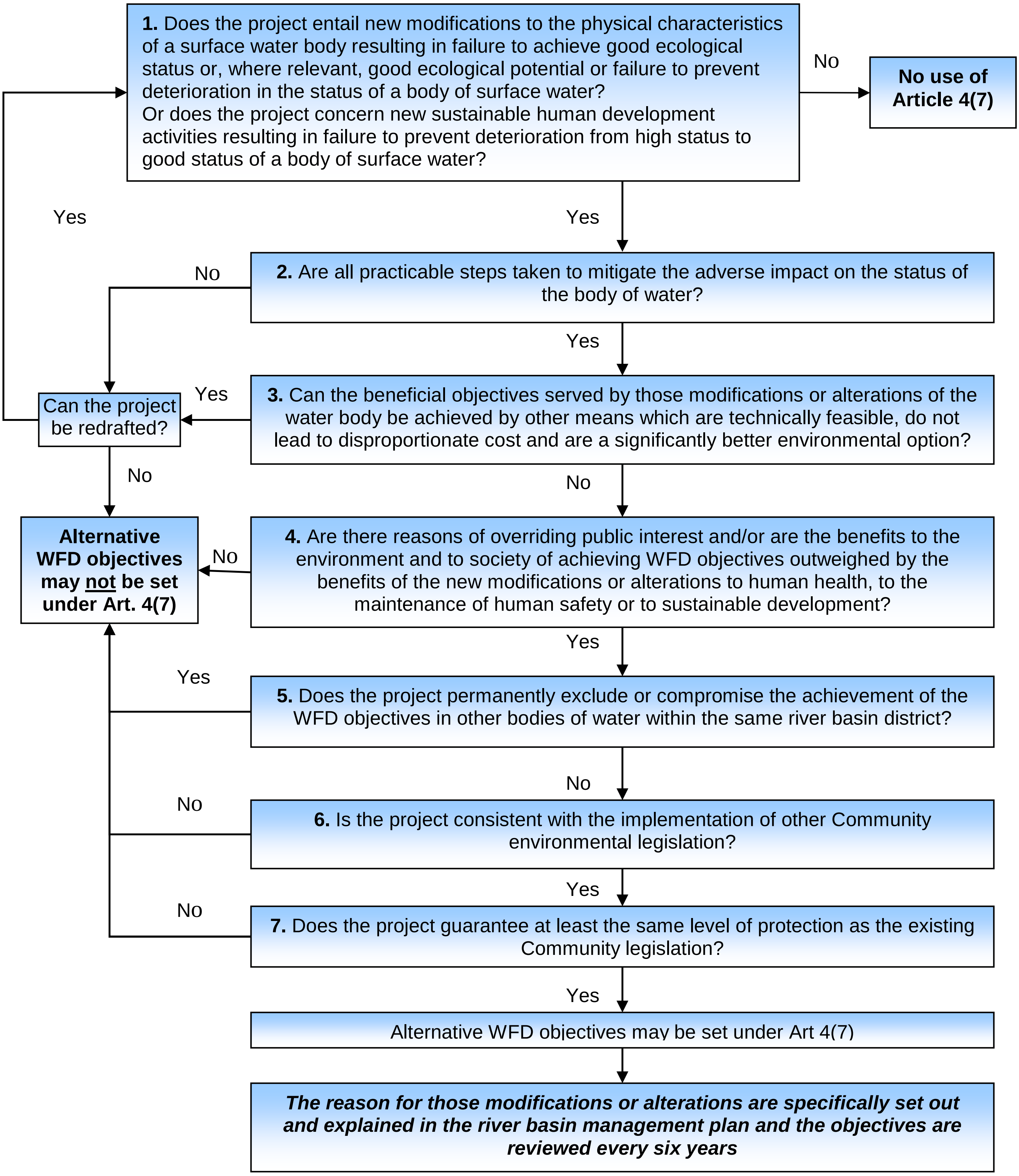


Figure 11.1: Step by step approach to the application of the conditions under Article 4(7) adapted from CIS, 2006(a) for relevance to TraC waters.

The following points of relevance to this study were clarified by CIS (2006(a):

- Article 4(7) will not be applied to temporary effects, i.e. if the condition of a water body is adversely affected for only a short period of time and recovers within a short period of time without the need for restoration measures. No definition is provided for ‘short period of time’, and how this is being interpreted by Member States is unclear at present.

- The information provided by EIAs for those projects that fall under the EIA Directive should be used in helping determine if the conditions of Article 4(7) are met (specifically relating to the consideration of alternatives). It is assumed that for projects that do not fall under the scope of the EIA Directive an assessment procedure will be confirmed (potentially by the DEHLG following input from PoMS studies) to determine if the conditions of Article 4(7) are met.

- Article 4(7) cannot be used as an exemption from fulfilling the legal requirements of other Directives (e.g. in relation to a Natura 2000 site both the conditions set out in Article 4(7) of the WFD and those set out in Article 6 of the Habitats Directive would have to be met).

It has yet to be clarified if the concept of “over-riding public interest” has the same meaning as under the Habitats Directive. Concern has been expressed as to whether available case law on the Habitats Directive would be relevant for the interpretation of the WFD (as noted by CIS 2006(a), and the issue was raised at a PIANC (Permanent International Association of Navigation Congress) workshop in January 2007, titled ‘Navigating the Water Framework Directive’). It was also suggested at this workshop that as the WFD does not require ***imperative reasons*** of overriding public interest (as with the Habitats Directive) the WFD regime appears to be less strict. It is considered unlikely that the imperative reasons of overriding public interest will permit a development which will have an adverse effect on the integrity of Natura 2000 sites to proceed.

Where the importance of the development is judged to outweigh the nature conservation importance of a site, the EU Birds and Habitats Directives require that compensatory habitat measures must be taken. However, the WFD does not specifically require the implementation of compensatory measures. CIS (2006a) suggests that reasons of ***‘overriding public interest’*** in relation to the WFD refer to ***“situations where plans or projects envisaged prove to be indispensable within the framework of***:

- ***"Actions or policies aiming to protect fundamental value for citizens' lives (health, safety, environment);***
- ***Fundamental policies for the State and the society;***
- ***Carrying our activities of an economic or social nature, fulfilling specific obligations of public services."***

As indicated in Figure 11.1 (Step 4), if no 'overriding public interest' can be demonstrated, it must be shown that the benefits to the environment and to society of achieving the WFD objectives are outweighed by the benefits of the new modifications or alterations ***"to human health, to the maintenance of human safety or to sustainable development".***

11.2 Decision Support for the Regulation of Physical Modifications

A primary requirement of the Marine Morphology PoMS Study was to develop a decision support tool to allow ***'systematic assessment of future marine morphological impacts on ecological status (/potential) by taking account of the existing quality status and pressures on the water body'*** (SWRBD, 2005). This objective has been achieved by the delivery of the following elements:

- **Pressures**: those pressures identified for the initial risk assessments were further characterised (Table 2.1, of Chapter 2) and spatially referenced to facilitate future assessment using GIS. The 'footprint' for each identified pressure was defined in addition to details regarding structure/activity type, scale of impact and frequency.
- **Registers of relevant EISs and marine models completed for TraC waters:** The detail provided can assist both the applicant and consent authority in the assessment of water body capacity.
- **Application of SEPA's morphological impact assessment tool TraC-MImAS:** Following contribution to the trialling and further development of TraC-MImAS, this tool was applied to a selection of TraC water bodies to help further characterise the identified pressures and the potential impacts on morphological conditions. This, in turn, further characterised the risk posed by existing physical modifications to the achievement of the WFD objectives. The results of this assessment will be considered by the EPA during formal classification of water body status.
- **Good Practice Guide:** This guide can be used to advise applicants during pre-application discussion of the likely appropriate measures.

- **Future trends:** Chapter 8 summaries the findings of a strategic review undertaken to identify potential developments across a range of sectors/pressures which could potentially impact on the morphological condition of TraC waters. This summary can help authorities predict the likely future pressures that may contribute to the failure of the WFD objectives in addition to those being proposed at present.

Article 11 (3)(i) of the WFD specifies that 'basic measures' shall consist of '***measures to ensure that the hydromorphological conditions of the bodies of water are consistent with the achievement of the required ecological status***' [or good ecological potential]. Controls for this purpose are suggested as taking the form of '***a requirement for prior authorisation or registration based on general binding rules where such a requirement is not otherwise provided for under Community legislation***'.

Chapter 10 summarised the existing Community legislation of relevance to the protection of TraC waters and highlighted where there is specific consideration of morphology. The following sections lead on from this by setting out where this legislation is used within the existing regulatory process of future physical modifications, and recommend how this process can be supplemented by the deliverables of this study. 'General binding rules' are not set out; however, general 'screening' rules are provided through the use of TraC-MImAS. With regard to '***prior authorisation'*** the importance of pre-application discussions between applicants and consent authorities is strongly emphasised

The aim of these discussions should be to minimise the number of applications received by consent authorities that are either rejected for being incomplete, require amendment or are refused for not meeting the relevant assessment criteria, whilst also creating an opportunity to promote Good Practice. At present the need for pre-application discussions is prescribed on a case-by-case basis, but formally required within the EIA process as well as for foreshore licence/lease and dumping at sea permit applications. The following sections make recommendations for the content of such discussions in relation to morphology and WFD compliance.
The use of TraC-MImAS at this level will help provide for fair and consistent regulation, i.e. the use of a defined screening tool at an early stage of any proposal will highlight any potentially significant issues for which an applicant can bring forward supporting information for site-specific cases.

11.2.1 Regulatory Process for the Authorisation of Developments consisting of Physical Modifications

Figure 11.2 below summarises the existing regulatory process concerning physical modifications and recommends the stages at which the deliverables of this study can supplement this process at a national level.

In the development of TraC-MImAS, SEPA envisaged that this tool would be applied within a two-stage regulatory screening process. Stage 1 would be a preliminary risk assessment using a defined area, i.e. applying MImAS for a local-scale assessment. This would be used to identify low risk proposals that do not threaten ecological status. Stage 2 would then assess if the water body could be threatened. A similar staged regulatory process is outlined here. However, the use of local-scale assessments is not recommended at present in Ireland. To ensure consistent national application of any regulatory process, generic rules should apply to all assessments. Therefore, if local-scale assessments were to be used, the same assessment area would need to be applied in all water bodies, of all shapes. Various options were investigated through the UK-TAG Technical Panel - however, further research is required before the defined area for such an assessment can be justified. Section 11.4.2 of this chapter discusses this issue further.

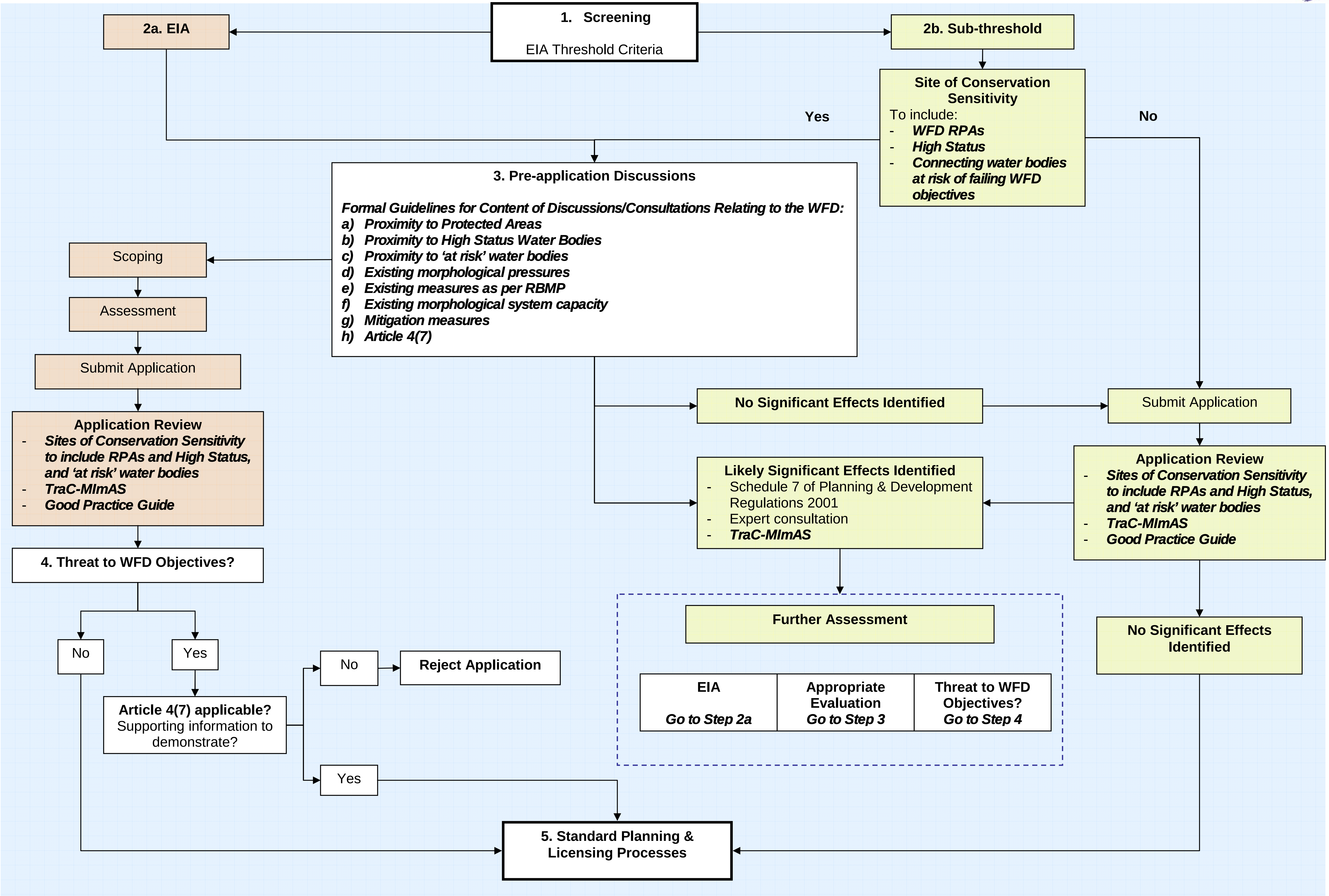


Figure 11.2: Summary of Existing Regulatory Process & Potential Improvements Regarding Coastal Morphological Pressures

11.2.2 Screening

As an initial stage to any project the developer will undertake 'screening' to determine whether or not the preparation of an EIS is required. This will initially involve a review of the mandatory and discretionary provisions set out in Irish legislation. As noted above, Schedule 5 of the Planning and Development Regulations 2001 provides the thresholds or sizes of certain classes of projects for which an EIS must be prepared, and those discretionary triggers that are associated with any sub-threshold developments.

It is considered that at this early stage there is a potential gap in the existing regulatory process regarding physical alterations. A sub-threshold development which does not fall in or on a site of conservation sensitivity can potentially fall 'out of the loop' of structured environmental assessment until the receipt of this application by the consent authority. The EPA adviseS that where projects pose a risk to such areas and are close to the mandatory thresholds developers should ***'consult with the relevant competent authority regarding the possible needs for an EIS'*** (EPA, 2002). Also, as referred to in Section 11.1.1 above, where possible, ***'pre-existing standardised terms for the significance of impacts'*** are advised for the ***'appropriate evaluation'*** of sub-threshold developments.

Pre-existing standardised terms may include reference to the RBMPs, specifically the status of water bodies, objectives set, and existing programmes of measures. However, as there are currently no specific references to this in national guidance; appropriate consultation regarding morphological alterations may not be triggered for sub-threshold developments until the formal application is reviewed by the consent authority.

With regard to dumping at sea applications; this initial screening stage is undertaken by the Marine Institute (Phase 1). The Marine Institute's 3-phased approach for assessing sediments is clearly outlined in 'Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters' (2006), details of which should be reviewed by a developer prior to submission to the Coastal Zone Management Division.

Based on the above, the following recommendations are made regarding future screening of TraC physical modifications and the potential threats to the achievement of the WFD objectives:

- Specific reference should be made within National EIS Guidance for consideration of RBMPs, and its associated objectives and programmes of measures

- An addition should be made to the EIA Regulations of the Protected Areas provided in Annex IV of the WFD as a trigger for the assessment of significant environmental effects for sub-threshold developments.
- An addition should be made to the EIA Regulations for High Status water bodies as a trigger for the assessment of significant environmental effects for sub-threshold developments.

11.2.3 Pre-application Discussions

The aim of these discussions should be to minimise the number of applications received by consent authorities that are either rejected for being incomplete, require amendment or are refused for not meeting the relevant assessment criteria; whilst also creating an opportunity to promote Good Practice.

Pre-application discussions can involve various parties depending of the characteristics of the proposal, and for the purpose of this report include information exchange via consultation letters. As noted above, following receipt of both planning and foreshore applications for sub-threshold developments a consent authority may determine that the proposal is likely to have significant effects on the environment and therefore request that an EIS be prepared. Screening and pre-application discussions are fundamental in determining if an EIS is required prior to the submission of formal applications, and will be of increased significance when reviewing the new requirements of the WFD in relation to morphology.

Using the findings of the screening assessment, it is considered that the following aspects should be included in pre-application discussions to help identify any potentially significant impacts of the proposal to the existing morphological condition of the relevant water body(ies). The outputs from pre-application discussions should help regulators determine if more detailed regulatory assessments will be required, and if deteriorations in status will require management by considering an exemption on the basis of benefits to human health, human safety or sustainable development (Article 4 (7)).

a) Proximity of proposal to Protected Areas (Natura 2000 network and WFD Registered Protected Areas).
b) Proximity of proposal to High Status water bodies.
c) Proximity of proposal to water bodies at risk of failing the WFD objectives (e.g. water bodies below GES, SAC classified as GES but requiring High Status for Favourable Conservation Status).

d) Existing pressures on morphological condition.
   - Pressure footprints have been identified and digitised where possible by this study for all Irish TraC water bodies.

e) Existing measures for the relevant water body(ies): the programme of measures specified in the current RBMP will be available to both developer and consent authority for discussion.

f) Existing morphological 'system capacity' of the relevant water body(ies) and likely threat to WFD objectives.
   - The existing system capacity of the water body(ies) can be estimated by the consent authority by applying TraC-MImAS as outlined in Chapter 5 of this report.
   - The results of TraC-MImAS will provide an indication of the remaining capacity of the water body(ies) to absorb morphological alterations without threatening the WFD objectives.
   - The likely significant pressure(s) can be screened by using TraC-MImAS.
   - It is at this stage that the consent authority may highlight the benefits of an applicant submitting GIS compatible data with the formal application - this will assist the initial assessment of the water body(ies) as well as contributing to the maintenance of the decision support framework.

g) Mitigation measures.
   - The Good Practice Guide provided in Chapter 7 of this report can be used to facilitate discussions regarding appropriate mitigation measures.
   - Following the indication of the most significant pressures, the requirement of measures can be focused.

h) Applicability of the WFD Article 4(7).
   - Based on the indicative results of TraC-MImAS; the potential applicability of Article 4(7) can be considered where relevant, i.e. if the proposal is indicating a threat to the WFD objectives due to physical modifications, or new sustainable human development activities.
   - The scope of information required to meet the conditions of this article can be reviewed to ensure that, if relevant, the applicant can adequately demonstrate achievement of these conditions in their formal application.

It is at this stage of the regulatory process that TraC-MImAS is considered to be of most use to the consent authorities in advising developers of their compliance needs whilst setting the scene for the next phase - Scoping. In consultation with the tool 'user', the potentially significant aspects of the proposal and receiving environment can be identified so as to determine the requirements for studies to assess these potential impacts, as well as identifying possible alternatives that could be addressed.

It should be demonstrated at this stage if it is considered likely that the development requires a full statutory EIS, and / or affects on a Protected Area [EU (Habitats and Birds Directives, WFD) and International].

Based on the above, the following recommendation is made regarding future consultations for TraC physical modifications and the potential threats to the achievement of the WFD objectives:

- For proposals including the pressures identified by this study, it is recommended that a formal request from the consent authority is made for information relating to the topics outlined in a) – h) above from the applicant would be fundamental to the success of the pre-application discussions.

11.2.4 Scoping

Scoping is the process through which the key issues specific to the proposed project or receiving environment that are likely to be of significance during the Environmental Impact Assessment (EIA), are identified. Scoping is a general requirement of the statutory EIA process, but should also be applied to sub-threshold developments, including those requiring foreshore licence/lease and/or dumping at sea permit, where significant environmental effects are considered likely. Screening and pre-application discussions with the consent authority (and other relevant bodies) are fundamental to the success of this stage of assessment by the applicant.

11.2.5 Receipt of Application

Depending on the scale of development, the consent authority can receive applications for planning permission, a foreshore licence/lease, dumping at sea permit and/or waste licence (e.g. for the reuse of dredge material for the purpose of reclamation). In accordance with the details outlined in Section 11.1.1 above, these applications may be accompanied by an EIS or other non-statutory Environmental Report (following an 'appropriate evaluation').

Following on from the pre-application discussions, the scope of the environmental report should adequately consider morphology where relevant. For the purpose of assessing compliance with the WFD in relation to morphology the following can be considered when reviewing submitted applications:

a) Potential risk to a Protected Area.
b) Likely threat to WFD objectives (TraC-MImAS).
c) Sufficient consideration of mitigation measures (Good Practice).

Protected Areas

The environmental report submitted should specify where proposed activities might threaten conservation interests, and any consultation responses relating to these interests should be provided with the application. The RBMP relevant to the RBD will identify the status required of any Protected Areas and outline the relevant objectives and programme of measures. It should also include '***maps indicating the location of each protected area and a description of the Community, national or local legislation under which they have been designated***' (Annex IV of the WFD).

Potential Threats to WFD Objectives

On receipt of detailed design information from the applicant, TraC-MImAS can be used to combine the pressure footprints envisaged for the proposal with those of existing physical modifications in order to assess the potential cumulative impact on the morphology of the water body(ies).

On publication of the RBMPs, each water body will be classified as representing High, Good, Moderate, Poor, or Bad status. If the assessment does not indicate that the impacts of the proposed physical modifications may result in a deterioration of the existing status class, and the accompanying environmental report provides sufficient evidence of this, then the standard planning and licensing processes may apply. However, if a risk to status class is demonstrated, the conditions of Article 4 (7) of the WFD should be reviewed to determine if its provisions are applicable.

Mitigation Measures

Accompanying environmental reports will outline those measures considered appropriate to the proposal. In addition to the expertise available from the relevant authorities, the marine morphology Good Practice Guide can assist a review of the likely effectiveness of the proposed measures. For those developments posing a risk to status class, the application should present evidence demonstrating:

- that all practicable measures to mitigate adverse impact on status were investigated;

- the reasons for any modifications/alterations being regarded as of overriding public interest; and
- that alternative means of meeting the objectives of the development have been identified and investigated to ensure that they do not present significantly better environmental options (subject to technical and economic considerations).

11.3 Worked Example: Inner Bantry Bay Proposed Harbour Development

This section uses an example of a proposed harbour development for Inner Bantry Harbour to demonstrate how the findings of the Marine Morphology Study can contribute to the existing regulatory system currently applicable to such a development, including that required of the WFD.

The details of the Inner Bantry Bay Proposed Harbour Development outlined in this section are sourced from development proposals prepared by RPS Consulting Engineers on behalf of Murnane and O'Shea Ltd (RPS, June 2006). This proposal was published by the Bantry Bay Commissioners as part of a tender request for harbour development. The purpose of this proposal document was to review past proposals for this harbour and prepare renewed proposals that would be made available to interested parties. This proposal was not intended to provide detailed plans of proposed works, but outline the concept elements. The areal extents of proposed structures and activities considered in the assessment below are only indicative of the latest proposal for the harbour. In addition to quoted pressure extents, many pressure footprints have been estimated using details indicated within the proposal document and accompanying plans. The Bantry Inner Harbour Development proposal was used only as a basis for this example and does not purport to accurately represent the proposal document.

Figure 11.3 shows the location of Inner Bantry Harbour within the WFD water body 'Inner Bantry Bay'. Currently Bantry Inner Harbour facilitates commercial fishing and aquaculture activity as well as providing an anchorage for small cruise liners with associated facilities. The harbour itself currently contains 2 piers in the outer area; a commercial pier to the south, and the (former) railway pier to the north of the harbour.

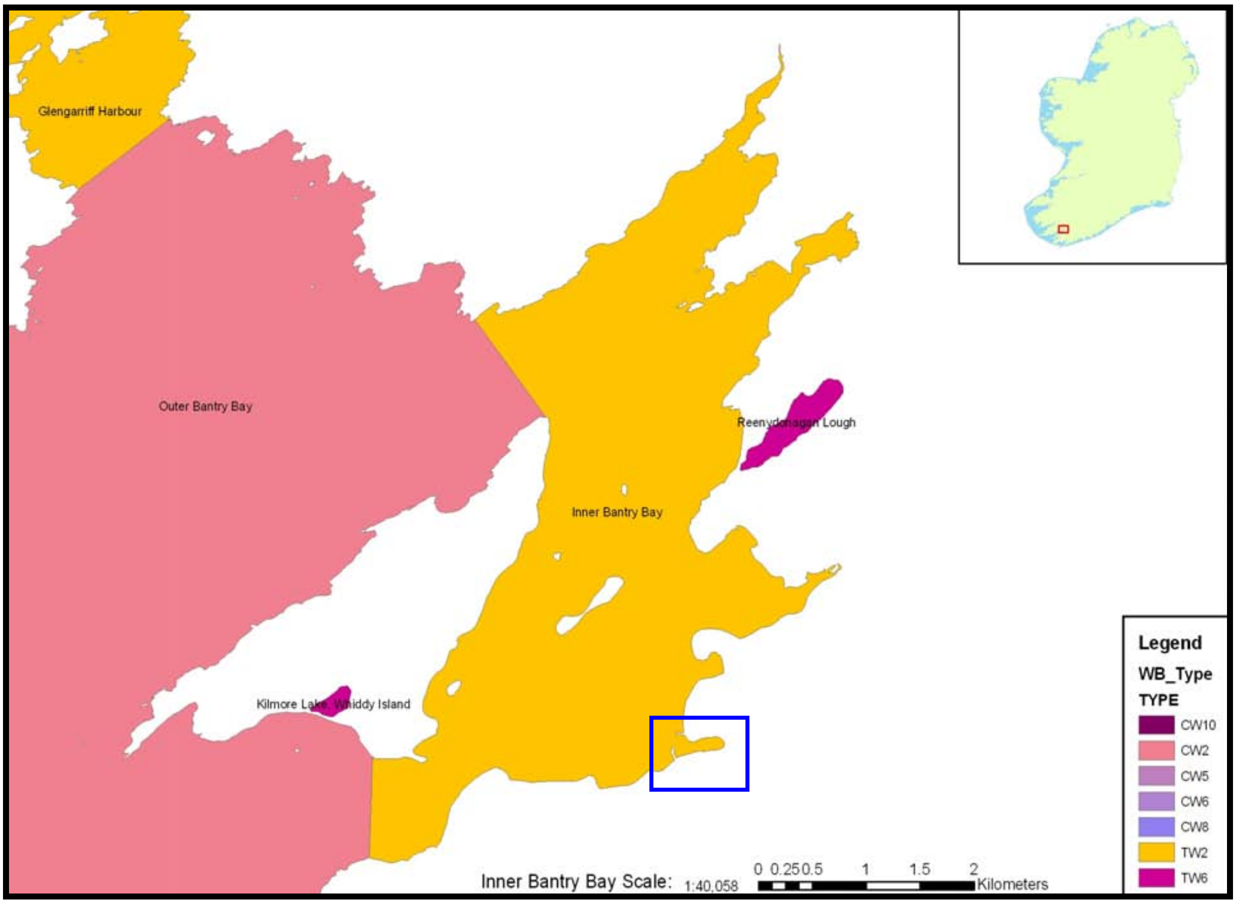


Figure 11.3: Location map – Inner Bantry Bay and Inner Bantry Harbour (outlined by the blue square)

The overall concept for the development of Inner Bantry Harbour included the proposals for the addition of public amenity areas (reclamation of approximately 0.162km^2 adjacent to the railway pier), pier extension and access (addition of approximately 700m^2 to the commercial pier), contamination treatment/removal, reinstatement of the Old Docks, and marina (188 berth) and onshore facilities.

Many harbour activities depend on hydromorphological modification. Potential impacts from such modifications can include:

- the physical removal of habitats or species;
- changes to physical processes (erosion, accretion and sediment transport); and
- barriers to movement of species or the loss of connectivity between habitat sites (e.g. due to impoundment or reclamation). (CIS, 2006(b)).

11.3.1 Screening

The proposed development ***exceeds*** the EIA threshold prescribed by the Planning and Development Regulations 2001, Schedule 5, Part 2. Those of relevance to such a development are as follows:

- ***New or extended harbours and port installations including fishing harbours, not included in Part 1 of this Schedule, where the area, or additional area, of water enclosed would be 20 hectares or more, or which would involve the reclamation of 5 hectares or more of land, or which would involve the construction of additional quays exceeding 500 metres in length***.
- ***Coastal work to combat erosion and maritime works capable of altering the coast through the construction, for example, of dikes, jetties and other sea defence works, where the length of coastline on which works would take place would exceed 1 kilometre but excluding the maintenance and reconstruction of such works or works required for emergency purposes.***
- ***Sea water marinas where the number of berths would exceed 300 and fresh water marinas where the number of berths would exceed 100***

Based on the above, a Statutory EIA would be required for such a development.

The water body of Inner Bantry Bay is not part of any SAC, SPA or NHA, however it is designated as a Registered Protected Area for the protection of economically significant aquatic species (PA3_0003) in accordance with Article 6 and Annex IV of the WFD.

It can be considered at this stage that the developer will be required to apply for the following licences/permits for such a proposal:

- Planning permission, to include an EIS.
- A licence and lease under the Foreshore Acts 1933 to 1998.
- A permit under the Dumping at Sea 1996 (amended 2004) will be required for disposal of dredged material. Following review by the Marine Institute a sampling and analysis plan may be advised.
- A waste licence from the EPA or permit from Cork County Council may be required for the reuse of dredged material and /or imported material for the purpose of reclamation.

Pre-application discussions may include Cork County Council, DAFF, the Marine Institute, Bord Iascaigh Mhara, South West Regional Fisheries Board, the EPA, as well as local fishery interests.

11.3.2 Pre-application Discussion

As noted in Section 11.2.3 above, pre-application discussions can involve various parties depending of the characteristics of the proposal, and include information exchange via consultation letters. Screening and pre-application discussions are fundamental in determining if an EIS is required or significant environmental effects are likely prior to the submission of formal applications, and will be of increased significance when reviewing the new requirements of the WFD in relation to morphology.

a) Proximity of proposal to Protected Areas (Natura 2000 network and WFD Registered Protected Areas)
   i. Register of Protected Areas for the protection of economically significant aquatic species (PA3_0003)
   ii. Natural Heritage Area - Cusroe, Whiddy Island (site code 000110)
   iii. National online interactive maps available via the NPWS as well as the RBMPs will assist in the identification of any new RPAs connected with Inner Bantry Bay.

b) Proximity of proposal to High Status water bodies
   i. Further characterisation of the risk associated with morphological alterations indicates that Inner Bantry Bay has potential to achieve HES, contributing to the achievement of overall high surface water status. The nearest TraC water bodies that also have the potential to achieve HES are Glengariff Harbour and Adrigole Harbour. An important point to raise in these discussions is that the extent of existing pressures within Glengariff Harbour currently impose some risk to the achievement of this status class, suggesting that only minor additional pressures on this water body may result in deterioration to GES.
   ii. National online interactive maps available via the EPA and RBMPs will assist in the identification of all surface water bodies connected with Inner Bantry Bay

c) Proximity of proposal to water bodies deemed at risk of failing the WFD objectives (e.g. water bodies below GES, Natura 2000 sites classified as GES but requiring High Status for Favourable Conservation Status)
   i. Based on the results of the Marine Morphology Study, those water bodies connected with Inner Bantry Bay are not currently at risk of failing GES.

d) Existing pressures on morphological condition

i. Pressure footprints were digitised where possible for all TraC water bodies, and should be available for interrogation by the consent authority.
ii. A summary of the existing pressure footprints for Inner Bantry Bay are outlined in the Water Body Summary Sheet 'SWRBD – 11' (Appendix 6-4) and Table 11.1, and illustrated in Figures 11.4 and 11.5 below.

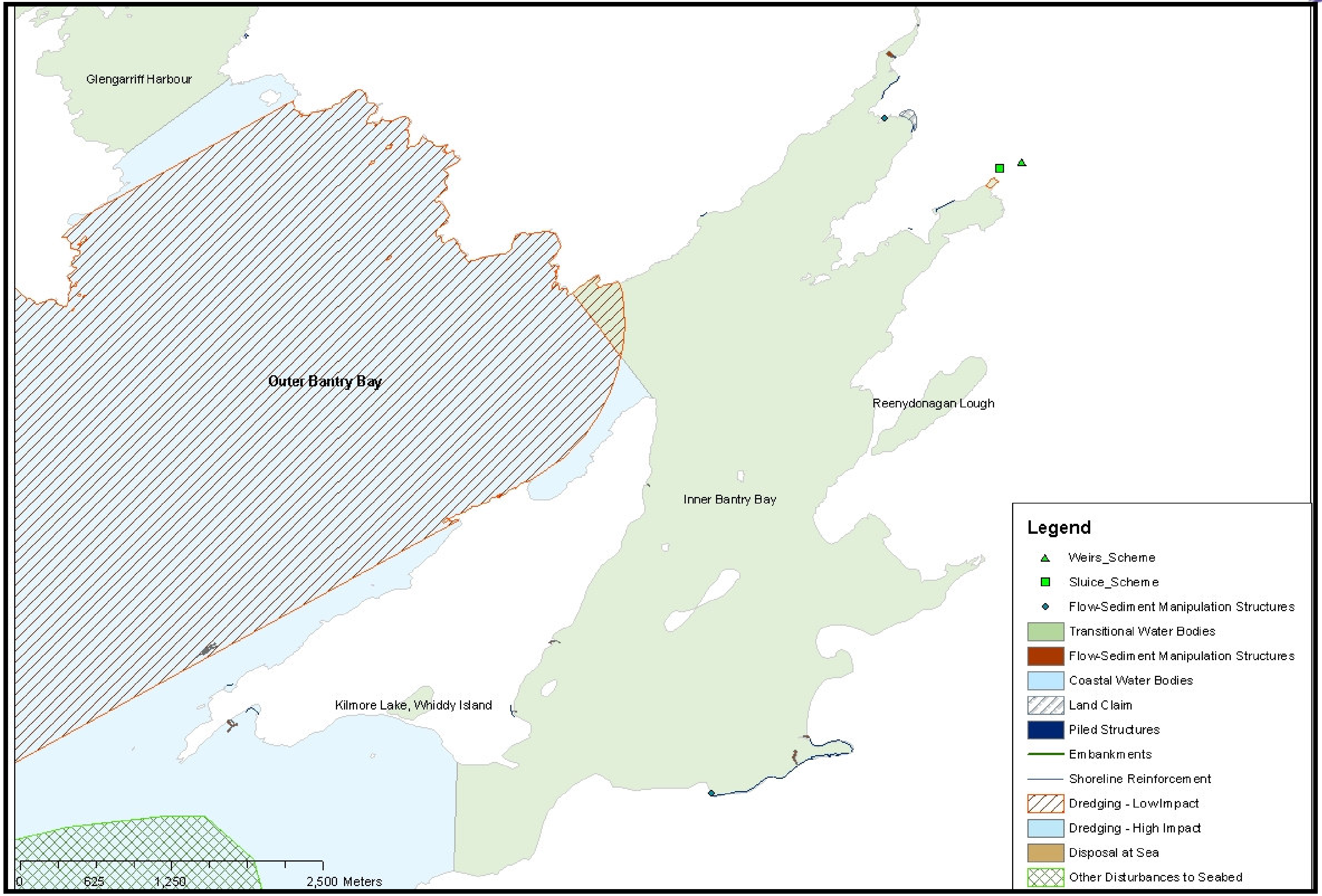


Figure 11.4: Existing Physical Modifications identified for Inner Bantry Bay, SWRBD

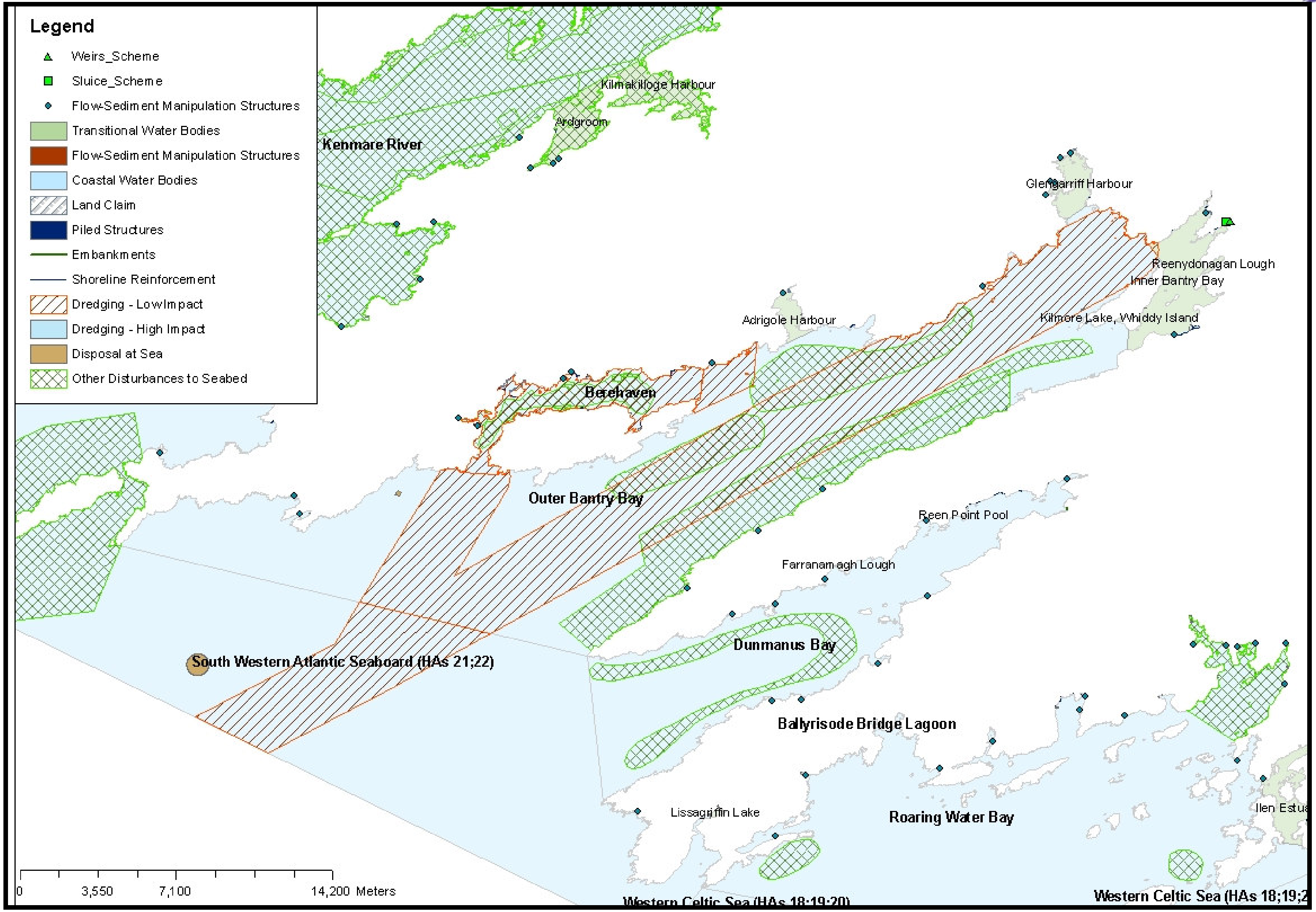


Figure 11.5: Existing Physical Modifications identified for Inner Bantry Bay and connected TraC water bodies, SWRBD

Table 11.1: Summary of existing pressure footprints identified for Inner Bantry Bay

		Transitional	
Pressures		Meso - macro Tidal	
		Location of Activity	
		Intertidal	Subtidal
Land claim- High impact	**Area (km²)**	0.009776	
Land claim- Low impact	**Area (km²)**		
Dredging- High Impact	**Area (km²)**		
Dredging- Low impact	**Area (km²)**	0.013904	0.135384
Other disturbances to seabed	**Area (km²)**		
Sea disposal of dredgings	**Area (km²)**		
Structure to manipulate flow/sediment	**Area (km²)**	0.003966	0.001199
Structures with piled supports	**Area (km²)**	0.00039	0.000166
Shoreline reinforcement- High impact	**Length (km)**	2.435	0.039
Shoreline reinforcement- Low impact	**Length (km)**		
Flood defence embankment	**Length (km)**		
Tidal channel realignment- High Impact	**Length (km)**		
Tidal channel realignment- Low impact	**Length (km)**		
Impounding structure	**Footprint rules apply**		
Causeway	**Length (km)**		

e) Existing programme of measures for the relevant water body(ies)

i. The published RBMPs will outline the PoMS defined for Inner Bantry Bay on completion of all PoMS studies.

ii. If confirmed to be of High Status, PoMS for this water body will focus primarily on the preservation of this status class.

f) Existing morphological ‘system capacity’ of the relevant water body(ies) and likely threat to meeting WFD objectives

i. TraC-MImAS can then be applied to the identified pressures footprints existing in Inner Bantry Bay to help inform the applicant of the current morphological condition of the water body, and therefore potential threats to the WFD objectives.

ii. The extent of pressures within Inner Bantry Bay currently indicates the potential for the achievement of HES, as demonstrated in Table 11.2 below.

Table 11.2: Existing system capacity estimated for Inner Bantry Bay

TOTAL CAPACITY USED		
Hydrodynamics	1.4%	HIGH
Intertidal Zone	2.8%	HIGH
Subtidal Zone	0.3%	HIGH

iii. Details of the proposed pressure footprints associated with the development may be available for review at this stage of the process. Those works associated with the proposed Inner Bantry Harbour development and considered of relevance to the assessment of morphology are outlined below:

- Pier widening and extension.
  - To include the use of sheet piles and dredged material.
- Dredging: sufficient depth at low tide for passenger & commercial vessels.
  - To facilitate access to proposed pier extension and access works.
  - Proposed dredge depth level at the eastern end of the harbour is -2.0m Chart Datum, increasing to -3.0 Chart Datum at the western end and harbour entrance.
  - In addition to this ‘capital’ project, these navigational areas will require ongoing maintenance.
- Reclamation (public & amenity areas).
  - Rock breaking required in areas.
  - Dredged material (potentially contaminated) and/or imported clean fill to be used for reclamation of 3 areas; totalling to an estimated land claim footprint of 0.01619km^2.
  - Impermeable barriers to consist of sheet piles, concrete retaining wall and armoured breakwater.
- Associated disposal of [contaminated] sediments: material may be used to supplement reclamation or disposed of outside this water body.

iv. A summary of the estimated pressure footprints associated with the Bantry Bay Inner Harbour Development proposal is tabulated below alongside those of the existing pressures identified for the Inner Bantry Bay water body (Table 11.3).

Table 11.3: Summary of existing pressure footprints within Inner Bantry Bay and those proposed for the Inner Harbour

Pressures	Existing Footprints m^2		Proposed Footprints m^2		Total Footprints m^2		Total Footprints Km^2		Comments
	Intertidal Zone	Subtidal Zone	Intertidal Zone	Subtidal Zone	Intertidal Zone	Subtidal Zone	Intertidal Zone	Subtidal Zone	
Flow-Sediment Manipulation Structures - Total	3966	1199	700	0	4666	1199	***0.0047***	***0.0012***	Estimated from concept plans: 'extending pier head by 10m, and increase width by 4m along entire width'
Commercial Pier	***1634***	***162***	***700***	***0***	***2334***	***162***			
Railway Pier	***497***	***0***	***0***	***0***	***497***	***0***			
Other	***1835***	***1037***	***0***	***0***	***1835***	***1037***			
Dredge (Low Impact)	13904	135384	0	0	13904	135384	***0.0139***	***0.1354***	Estimated area of harbour outside that proposed for reclamation to be dredged (capital dredge proposal).
Dredge (High Impact)	0	0	31047	22084	31047	22084	***0.0310***	***0.0221***	
Shoreline Reinforcement (High Impact)	2435	39	-460	0	1975	39	***1.9750***	***0.039***	Reclaimed areas to include impermeable banks, therefore, the footprint of existing reinforcement should be removed to prevent double counting of pressures by TraC-MImAS.
Land Claim (High Impact)	9776	0	8096	8096	17872	8096	***0.0179***	***0.0081***	Proposed area estimated using concept plans. Footprint evenly split between tidal zones
Piled Structures	390	166	0	0	390	166	***0.00039***	***0.0002***	
Disposal	0	0	0	0	0	0	***0***	***0***	Site not specified for disposal

v. Using the details for the proposed pressure footprints, TraC-MImAS can be applied to indicate the likely threat to the existing morphological conditions by estimating the water body's system capacity.

- Table 11.4 below shows the results of TraC-MImAS following the addition of the proposed pressure footprints to Inner Bantry Bay.

Table 11.4: Estimated system capacity for Inner Bantry Bay with proposed harbour development

TOTAL CAPACITY USED		
Hydrodynamics	1.3%	HIGH
Intertidal Zone	5.6%	GOOD
Subtidal Zone	0.5%	HIGH

- The estimated system capacity used following the increase of physical modifications indicates that these modifications **could potentially result in a deterioration of water body status**.
- The most significant pressures attributing to the potential deterioration are land claim and high impact dredging. Both of these pressures can alter local tidal flow patterns, sediment transport regime in addition to direct removal of habitat and biodiversity. Also, in addition to potential local impacts of a capital dredge scheme, the sensitivity of shellfish associated with the RPA to increases in suspended sediment levels, smothering etc are potentially significant pressures on water body status.
- On publication of the RBMPs, formal ecological classification results will assist further.

g) Mitigation measures

i. In accordance with Article 4(1) of the WFD; necessary measures should be implemented to prevent the deterioration of the status of all surface water bodies (subject to Articles 4 (6) and (7), and without prejudice to (8)).

ii. Potential measures that could potentially reduce the impact of the proposed physical modifications (see Chapter 7) may include:

- **Reconsider location of reclamation:** monitoring results will help inform both applicant and authority of ecologically sensitive areas. Other than the RPA, no particularly sensitive areas have been identified in the Inner Bantry Harbour

- **Modify structure design:** the feasibility of open-piled structures may be considered for the proposed amenity area and pier improvements. Semi-permeable breakwaters proposed to shelter boats and pontoons could be investigated.
- **Modify dredge methods:** the feasibility of dry-dredging the inner harbour could be investigated as well as seasonal and tidal timings for other dredge methods. If feasible, dry-dredging of the Inner Bantry Harbour would help minimise the potential impact on local shellfish. The construction of a bund reinforced with sheet piles extending between the existing commercial pier and the existing railway pier is recommended within the proposal (RPS, 2002) as a measure to minimise migration of the sediment plume into the Bay. It should be noted that Article 4(7) only applies to temporary deterioration if this is the '***result of circumstances of natural cause or force majeure***'.
- **Management Frameworks:** As noted above, the navigational areas required for the harbour will require ongoing maintenance. A proactive approach to the imminent requirements of the WFD could include the development of maintenance dredging frameworks that can facilitate the management of sediment through the control of dredging operations.
- **Disposal of dredged material:** Re-use of material within the development proposal is an option, however, in addition to morphological considerations; those relating to contaminated sediments will need to be addressed. Similarly with disposal outside this water body, contaminated sediments will require more stringent measures than those associated with conservation of morphological conditions. It is considered that, in the case of non-hazardous sediment, the disposal/relocation of sediment at sea is beneficial as it can continue to contribute to its natural role in the environment.

iii. During the next stage of this process, the applicant should investigate the potential measures discussed, particularly those associated with land claim and high impact dredging.

h) Applicability of the WFD Article 4(7)

i. Making reference to the CIS Guidance (CIS 2006), and Figure 11.1 above, the consent authority may, if relevant, outline the requirements of the applicant to demonstrate the applicability of this derogation.

ii. On consideration of the measures outlined above, the potential impact of the proposed development may be significantly reduced; therefore supporting documentation demonstrating the conditions of Article 4(7) is unlikely for such a development.

11.3.3 Receipt of Application

TraC-MImAS may be applied again if the pressures footprints initially proposed are amended. For example, if permeable breakwaters and open-piled structures are proposed, these pressures could then be assessed as low impact shoreline reinforcement and piled structures in place of high impact shoreline reinforcement and land claim. However, it is important to note that TraC-MImAS does not currently account for the potential benefits of all mitigation measures (e.g. dredge methods or reclamation of less sensitive area). It is therefore recommended that, pending further development TraC-MImAS is of most benefit to the Screening and Pre-application regulatory process stages.

Following consideration of TraC-MImAS results, the formal status class, relevant objectives and PoMS outlined in the RBMP, as well as expert review of the risk to the WFD objectives can be confirmed. If the proposal continues to pose a risk to status class, the applicability of Article 4(7) should be investigated. The potential for the use of derogations is highlighted at the pre-application discussions. Therefore, any application should, where considered relevant, provide sufficient information to facilitate this review.

11.4 Further Development

As outlined in the above sections, the deliverables of the Marine Morphology Study and current version of TraC-MImAS can help support Ireland's existing regulatory process for the assessment of WFD compliance relating to physical modifications. However, as highlighted in Chapters 3 and 5 there are opportunities to refine this process through improvement to both the base data and the assessment tool.

11.4.1 Base Data and TraC-MImAS

The overall framework of TraC-MImAS is considered a valid basis for developing further research and development work to provide validation of the professional judgement values and/or assumptions applied in the tool. This is the long term intention of SEPA for TraC-MImAS, and work has already commenced for the Rivers-MImAS tool.

The development of TraC-MImAS was initiated by SEPA following the success of the River-MImAS tool as a regulatory aid in Scotland. River-MImAS has been developed within the database software, Oracle, and its application within Scottish water bodies is supported by a documented internal Regulation Method which defines the steps necessary to authorise an engineering activity, as well as an Operational Guide which provides SEPA staff with detailed information on the use of the rivers tool (similar to that provided in Chapter 5 for TraC-MImAS). This structured methodology aims to reduce the time required for expert judgement, by guiding staff towards screening out low risk proposals that are unlikely to threaten WFD objectives. This has yet to be duplicated for TraC waters. It is considered that further technical development of TraC-MImAS, in addition to confirmation of regulatory roles and responsibilities are required before such a formal regulatory procedure can be documented with confidence for use in Ireland. However, as research and development is continuing within SEPA, it is strongly recommended that Ireland continue liaisons with them during the refinement of TraC-MImAS as a regulatory tool.

The following is a summary of how this report can facilitate both the use and refinement of TraC-MImAS:

- Chapter 9 outlines how Irish monitoring programmes can help increase confidence in the underlying assumption of TraC-MImAS, i.e. an assessment of impacts on ecologically relevant features and processes (as defined in Table 5.6) can be used to protect morphology and ecology;
- Chapters 3 and 5 outline the methods and information required for the assessment of both existing and proposed developments using TraC-MImAS; and
- Chapter 5 also recommends potential improvements to each of the five TraC-MImAS modules, the most prominent being that of the Typology Module. Within TraC-MImAS, the sensitivity of both morphology and ecology is estimated based on the water body ***type*** - therefore, future development should focus on this module.

Further field trials, monitoring results, and professional judgement across Ireland and the UK will all benefit the refinement of TraC-MImAS; however, due to the nature of estuarine and coastal water bodies, TraC-MImAS or any similar tool developed has limited capabilities for the assessment of site specific conditions. Therefore, further development should be focused at refining this tool for its continued use in ***supporting*** regulation with the aim of formalising a national, non-sectoral, regulatory framework which TraC-MImAS can assist.

In addition to the benefits of screening coastal proposals, the use of TraC-MImAS in the regulatory process will encourage the use of GIS by applicants and therefore improve the acquisition of national pressure footprints. However, this then raises the problem of data quality and scale. At present, WFD water bodies and their shorelines have been digitised at a scale of 1:50,000, whereas applicants are likely to submit proposal plans at larger scales. This will need to be considered when using TraC-MImAS to assess the potential impact of a proposal.

A significant component of TraC-MImAS is its reliance on the extent of a water body's area and shoreline length in estimating system capacity. Therefore, to ensure a good level of confidence in the use of TraC-MImAS for regulation, a high level of confidence is firstly required in water body areas as well as typology.

Chapters 3 and 6 highlighted some digitising errors relating to water body extents. These are minor errors that should be corrected on completion of all PoMS studies. However, of more relevance to the confidence in regulatory tools, it was identified that the delineation of various other water bodies may be questioned by an applicant during regulation. For example, Dun Laoghaire Harbour, an enclosed harbour within the 'Dublin Bay' water body (48 km^2), is not designated as a separate HMWB and therefore will be required to achieve GES by 2015. Therefore, the impact of any changes in the area within the piers must not be such that it would cause the waters of 'Dublin Bay' to fall below good status. Water bodies delineated as 'heavily modified are subject to the less stringent objective of GEP.

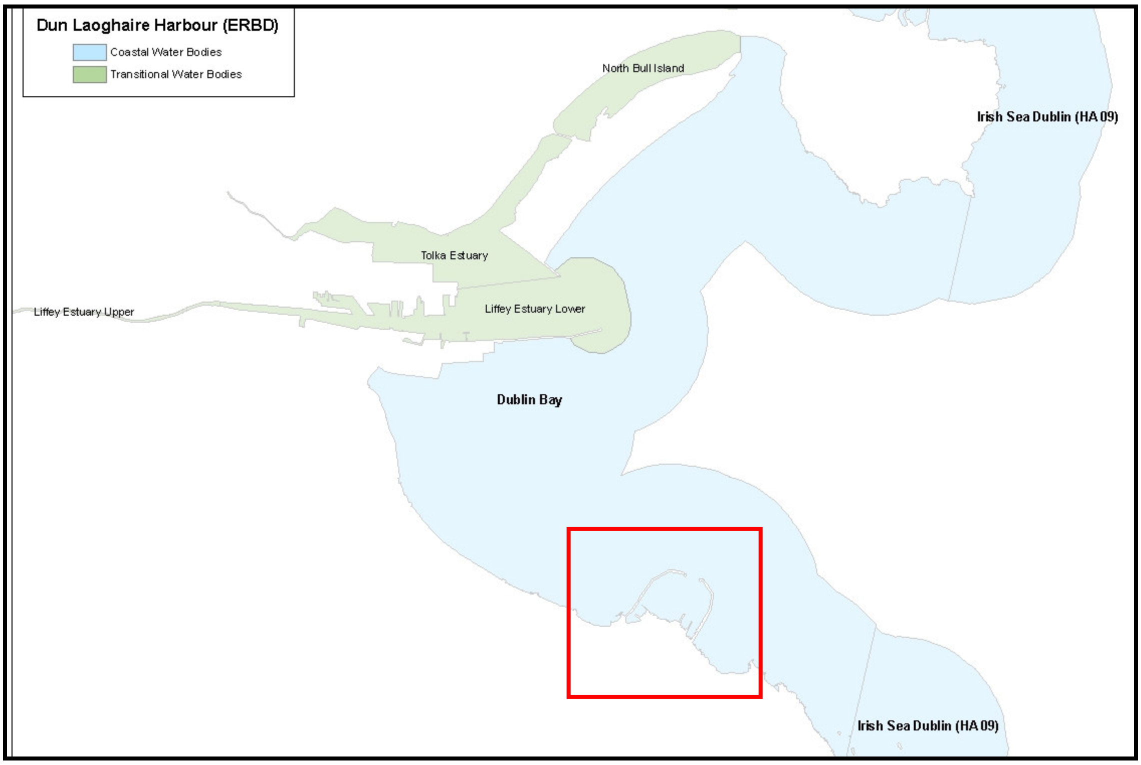


Figure 11.6: Dun Laoghaire Harbour within the coastal water body Dublin Bay.

The Dargle estuary provides another example. This water body was not designated as a provisional HMWB. However, historic maps show that this water body was created by land reclamation and the construction of flow and sediment manipulation structures, as shown in Figure 11.7 below.

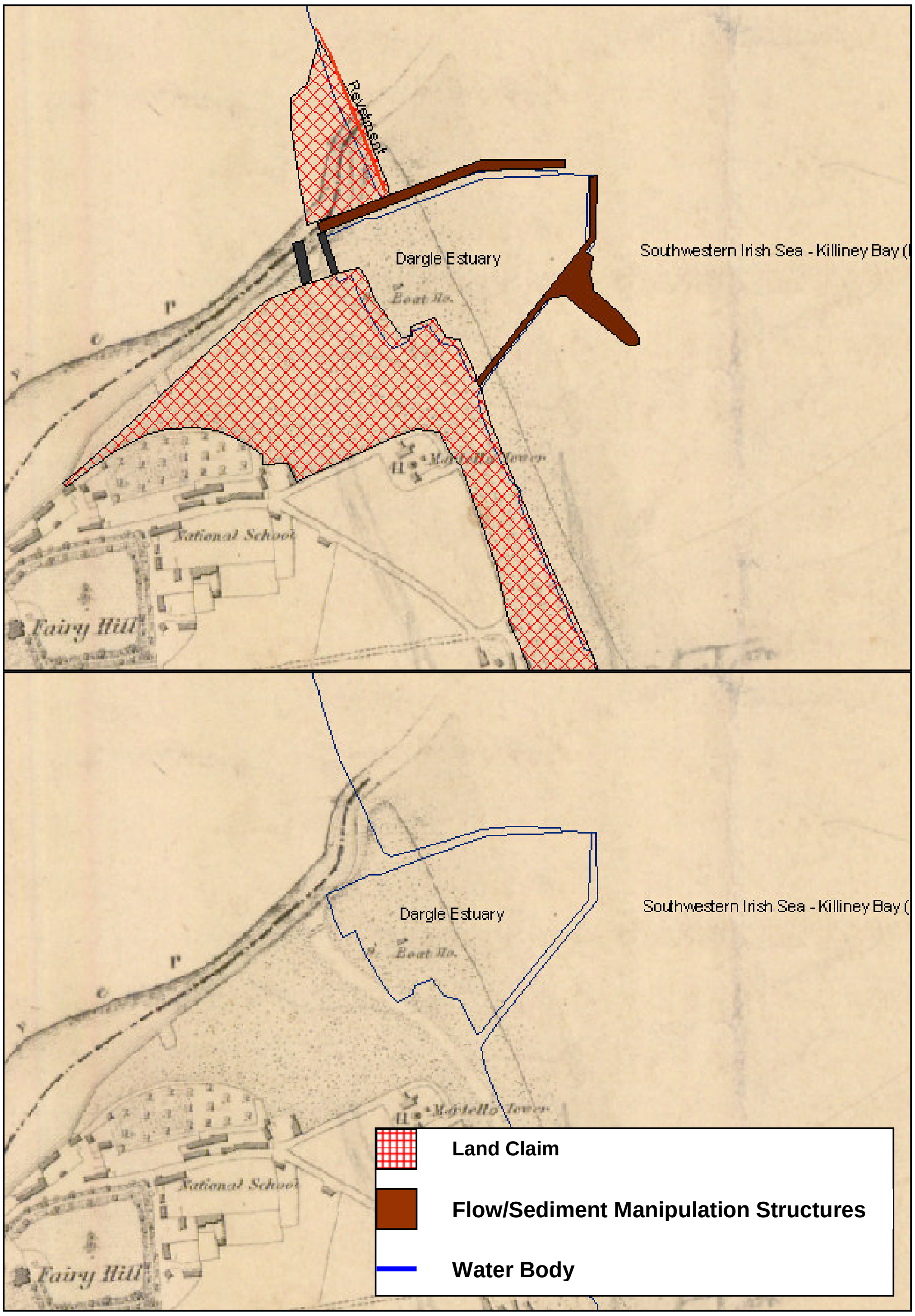


Figure 11.7: Dargle Estuary Transitional Water Body. Historic maps sourced from GSI

11.4.2 Water Body Scaling and Single Activity Limits – Thresholds for Screening

As introduced in section 11.2.1, SEPA have investigated the use of local-scale assessments, which were aimed at

- screening out those proposals not considered to threaten WFD objectives within a defined local assessment area, and therefore unlikely to be of significance at water body scale; and
- identifying any proposals that may have a significant impact at local scale but perceived as having no significant impact if assessed within a large water body. For example, a proposal for a small harbour development in a sedimentary area of a large predominantly bedrock water body is unlikely to impact significantly on the water body as whole, but may adversely affect sensitive habitats dependent on the sedimentary conditions, therefore impacting on water body status.

Local-scale assessments have yet to be trialled across the UK and Ireland. Initial proposals included a defined square assessment area of $0.25km^2$, but further research has deemed this impractical due to the site specific nature of estuarine and coastal waters and their developments. In terms of sensitive habitats in the vicinity of a proposal, it is considered that the regulatory process outlined in Section 11.2 above will ensure the consideration of such areas without the use of defined assessment areas within a water body.

Within the UK-TAG work has commenced on the definition of 'single activity limits' for discrete morphological alterations which could be applied to water bodies of any size, with the exception of lagoons. An activity exceeding these limits would indicate a risk to High status. Formal results of this work have yet to be published as field trials will be required to further research these limits. The adoption of such limits will require a high level of confidence in their ability to trigger adverse impacts on morphology and ecology, and in the absence of extensive field trials and monitoring the draft activity limits currently proposed are not considered suitable for use in regulation in Ireland as yet. However, continued liaison with SEPA as well as contributing to this work to mimic studies in Ireland, can help define these limits for future use. In addition to the thresholds provided by the EIS Regulations, evidence-based activity limits would prove beneficial to the regulation of morphological alterations.

REFERENCES

- ABPmer (2002). Potential effects of offshore wind developments on coastal processes. ETSU W/35/00596/00/REP.

- ABPmer (2007) Online Managed Realignment Guide. Available from http://www.abpmer.net/omreg [Assessed 16 Jan 2008].

- Barry, J.B. and Partners in association with Irish Hydrodata Ltd. and Reid and McHugh and Partners (1988). Water quality plan for Bantry Bay, Report to Cork County Council, 3 Vols.

- Berrow, S., Whooley, P. and Wall, D. (2006). ISCOPE – Irish Scheme for Cetacean Observation and Public Education, Final Report (2003-2005). ***Irish Whale and Dolphin Group Merchants Quay, Kilrush, Co Clare.***

- Borja, A., Franco, J. and Muxica, I. (2003). Classification tools for marine ecological quality assessment: The usefulness of macrobenthic communities in an area classified by a submarine outfall. ***International Council for the Exploration of the Sea Conference***.

- Brooke, J. (2005). Scoping of Economic Impacts and Issues in Transitional and Coastal Waters. Report to DEFRA.

- Carp, E. (1980). Directory of Wetlands of International Importance in the Western Palearctic, ***United Nations Environment Programme, International Union for Conservation of Nature and Natural Resources, World Wildlife Fund***. 217-218.

- Casey, J., De Grave, S., Burrell, M. (1998). Intersex and Imposex ***Littorina littorea*** in Cork Harbour. ***Hydrobiologia***. **378**. 193-197.

- Central Fisheries Board (2006) METRIC Estuarine Investigations, Drongawn Lough, Sneem[online] Available from http://www.cfb.ie/fisheries_research/estuaries/drongawn.htm [Accessed 18 Feb 2008].

- Central Fisheries Board (2006) METRIC sampling programme of transitional waters, EPA [online]. Available from http://www.cfb.ie/fisheries_research/estuaries/kenmare.htm [Accessed 18 Dec 07].

- Central Fisheries Board and The Marine Institute (2006). METRIC Programme – Fish in Transitional Water for the Water Framework Directive. ***Environmental Protection Agency Funded Project***. http://www.cfb.ie/fisheries_research/environment/projects/metric.htm.

- CIRIA (2004) Coastal and Estuarine Managed Realignment - Design Issues. Construction Industry Research and Information Association.

- CIS (2003). Identification and Designation of Heavily Modified and Artificial Water Bodies.

- CIS (2004). Policy Summary: Typology, Reference Conditions and Classification Systems. Produced by Working Group 2.3 (REFCOND).

- CIS (2006) WFD and Hydromorphological Pressures - Technical Report: Good practice in managing the ecological impacts of hydropower schemes; flood protection works; and works designed to facilitate navigation under the Water Framework Directive. EU Common Implementation Strategy Hydromorphology Working Group report.

- CIS (2006a). WFD and Hydro-morphological pressures Policy Paper – focus on hydropower, navigation and flood defence activities. Recommendations for better policy integration.

- CIS (2006a). Exemptions to the Environmental Objectives under the Water Framework Directive allowed for new modifications or new sustainable human activities (WFD Article 4.7). Policy Paper.

- CIS (2006b). Good practice in managing the ecological impacts of hydropower schemes, flood protection works and works designed to facilitate navigation under the Water Framework Directive.

- Clayton, P., Buchanan, C., Cummins, V., Sealy, S., O'Leary, D., O Mahony, C. and Pfeiffer, N. (2003). Aquaculture and Coastal Economic and Social Sustainability - Envireoview Report, ***University College Cork Coastal & Marine Resources Centre***.

- Clayton, T. (2002). Socio-Economic Profile of Coastal Communities in Ireland: Bantry Bay, Co. Cork and the Dingle Peninsula (Valentia Island to Kerry Head), Co. Kerry. ***University College Cork Coastal & Marine Resources Centre.***

- Clonan, E. (2002). Summary reports of larger discharges (≥2 Tonnes) and salvage incidents involving IRCG During 2002. ***The Irish Coast Guard***. Available from http://www.epa.ie/downloads/pubs/other/indicators/soe2004/epa_state%20of%20the%20environment_report_2004_chap_04.pdf.

- Connolly, N., Buchanan, C., O'Connell, M., Cronin, M., O'Mahoney, C. and Sealy, H. (2001). Assessment of Human Activity in the Coastal Zone: a research project linking Ireland and Wales, ***University College Cork Coastal Resources Centre***.

- Connor, D, Allen J, Golding, N, Howell, K, Lieberniecht, L, Nortern, K, & Reker, J, (2004) The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough ISBN 1 861 07561 8 (internet version)

- Cook, A. and McMath, A. (2001). Sensitivity and mapping of inshore marine biotopes in the southern Irish Seas (SensMap): Development of a protocol for assessing and mapping the sensitivity of marine species and benthos to maritime activities.

- Corepoint (2007). Coastal Research and Policy Integration [online]. Available from http://crc67.ucc.ie/corepoint/background. [Accessed on 12 Jan 2008].

- Council Recommendation 92/C/59/01 on the future of Community policy concerning the European coastal zone.

- County Clare Heritage Council (2006). ***Landscape reports: Blackhead Bay***, Clare County Council.

- Cromane Community Council (2007). Castlemaine Harbour Co-operative Society Ltd [online]. Available from Castlemaine Harbour Fishing Co-operative. [Accessed 03 Dec 07].

- Cronin, M., McGovern, E., MacMahon, T., Boelen, R. (2006). Guidelines for the Assessment of Dredge Materials for Disposal in Irish Waters. Marine Institute and Health Series, No. 24, 2006.

- Cummins, V., Connolly, N. and Burnell, G. (1999). An assessment of the potential for the sustainable development of the edible periwinkle, ***Littorina littorea***, industry in Ireland, ***Journal of Shellfish Research***. **18**(2), 713.

- Cummins, V., O'Mahony, C. & Connolly, N (2004). Review of Integrated Coastal Zone Management & Principals of Best Practice, Heritage Council.

- Curtis, T. G. F. and Skeffington, M. J. S. (1998). The salt marshes of Ireland: An inventory and account of their geographical variation. ***Biology and environment: Proceedings of the Royal Irish Academy.*** **98**(2). 87-104. http://www.ria.ie/cgi-bin/ria/papers/100435.pdf.

- DCMNR (2004). Castletownbere Fishery Harbour Development Environmental Report 0012024. Department of Communications, Marine and Natural Resources. Available from http://www.dcmnr.gov.ie/Marine/Fishery+Harbours/.

- DCMNR (2007). ***Major Foreshore licences granted***, Department of Communications, Marine and Natural Resources website [online]. Available from www.dcmnr.gov.ie/Marine. [Accessed 14 Dec 07].

- DCENR (2008). ***Marine Section***, Department of Communications, Energy and Natural Resources website [online]. Available from http://www.dcmnr.gov.ie [Accessed 07 Feb 08].

- DCENR (2008). Department of Communications, Energy and Natural Resources, Energy White Paper. Available from http://www.dcmnr.gov.ie/NR/rdonlyres/54C78A1E-4E96-4E28-A77A-3226220DF2FC/27356/EnergyWhitePaper12March2007.pdf.

- Dee and Glyde Fishing Development Association. (2007). Website [online]. Available from http://www.deeandglyde.com/. [Accessed on 03 Apr 08].

- Department of Environment, Heritage and Local Government (2007). River Basin Management Planning. A practical Guide for Public Authorities. Draft Guidance and Policy Direction.

- Department of Environment, Heritage and Local Government - National Spatial Strategy for Ireland 2002-2020. [online] Available from http://www.nss.ie/. [Accessed on 11 Feb 08].

- Department of Environment, Heritage and Local Government - The National Development Plan (NDP). [online] Available from http://www.ndp.ie [Accessed on 11 Feb 08].

- Department of Environment, Heritage and Local Government [online]. Available from www.environ.ie/en/DevelopmentandHousing/PlanningDevelopment/Planning/ [Accessed on 06 Jan 2008].

- Department of Transport (2006). ***Future seaport capacity requirement for unitised trade in Ireland***, Department of Transport.

- Dover Harbour Board (2006). Dover Harbour Board Environmental Bulletin 2006.

- Dublin City Council (2006). ***Dublin Water Feasibility SEA***. Available from www.dublincity.ie.

- Eastern Regional Fisheries Board (2008). Fly fishing in Wexford. Salmon and trout fishing. ERFB [online] Available from http://www.fishingireland.net/index.htm [Accessed 05 Mar 2008].

- EEA (1996). Surface water quality monitoring***, European Environment Agency***. No. 2/1996.

- Elliot, M. and Cutts, N. D. (2004). Marine habitats: loss and gain, mitigation and compensation. Marine Pollution Bulletin. **49**, 671-674.

- Elliott, M., Burdon, D., Hemingway, K. L., and Apitz, S. E. (2007). Estuarine, coastal and marine ecosystem restoration: Confusing management and science - A revision of concepts. Estuarine, Coastal and Shelf Science. **74**, 349-366.

- Entec (2006). Benchmark costs database and guidance on the application of the cost-effectiveness methodology. DEFRA.

- EOLAS (1988). Environmental Impact Study: Proposed Single Point Moorings at Bantry Bay, Co. Cork, ***Bantry Terminals Ltd***.

- EPA (2002). Guidance on Information Management and Data Interchange between River Basin Management Systems and National Organisations, Compass Informatics. ISO 19115:2003 Information technology: Geographic information – Metadata, International Standards Authority. ISO/IEC 11179: 2004 Information technology — Metadata registries (MDR), International Standards Authority.

- EPA, (2002). Guidelines on the information to be contained in Environmental Impact Statements. The Environmental Protection Agency, Wexford, Ireland.

- EPA (2003). National Environmental Monitoring Programme for Transitional, Coastal and Marine Waters. ***Environmental Protection Agency***.

- EPA (2006). Ireland: Water Framework Directive Monitoring Programme.

- EPA (2006). Water Framework Directive Monitoring Programme, Environmental Protection Agency.

- Essink, K. (1997). Risk Analysis of Coastal Nourishment Techniques. ***National Institute for Coastal and Marine Management / RIKZ***.

- Essink, K. (1999). Ecological effects of dumping of dredged sediments: options for management. Journal of Coastal Conservation. **5**, 69-80.

- European Commission (1997). Better Management of Coastal Resources. A European programme for integrated coastal zone management. Office for Official Publications of the European Communities, Luxembourg.

- European Commission (1999). Towards a European Integrated Coastal Zone Management (ICZM) Strategy. General Principles and Policy Options. A reflection paper. Directorates-General Environment, Nuclear Safety and Civil Protection; Fisheries; Regional Policies and Cohesion.

- European Commission (2000). Commission proposal for a European Parliament and Council Recommendation concerning the implementation of Integrated Coastal Zone Management in Europe (COM/2000/545), adopted 8 September, 2000.

- European Commission (2001). EU Focus on Coastal Zones. Turning the tide for Europe's coastal zones. Directorate-General Environment, Nuclear, Safety and Civil Protection.

- European Environment Agency (2006). The changing face of Europes' coastal areas, EEA report No 6/2006, ***European Environment Agency***, Copenhagen.

- European Sea Ports Organisation (2007). ESPO Code of Practice on the Birds and Habitats Directives.

- Eurosion (2002). Coastal Erosion Indicators Study, Eurosion B4-3301/2001/329175/MAR/B3.

- FAO (2007). The Workshop on Vulnerability Ecosystems and Destructive Fishing in the Deep-Sea Fisheries***,*** FAO, Jun 2007.

- FAO (2008). Technical Consultation on International Guidelines for the Management of Deep-Seas Fisheries in the High Seas, FAO Feb 2008.

- Fergal MacCabe Architect & Town Planner (1998). Environmental Impact Statement: Proposed Holiday Camp Incorporating 58 Holiday Homes and Amenity Clubhouse at Ventry, Co. Kerry.

- Forbes, E. and Hanley, S. (1853). A history of British Mollusca and their shells, vol. 1-4. London: John van Voorst.

- French, W. P. (2001). Coastal Defences: Processes, Problems and Solutions. Routledge, London, ISBN:0415198445.

- Greer Walker, M. and Nichols, J. H. (1993). Predation on ***Benthosema glaciale (Myctophidae***) by spawning mackerel (scombrus). ***Journal of Fish Biology***. **42**(4), 618-620.

- Goodwillie, R. (1979). Conservation and advisory amenity service planning division: A Preliminary Report on Areas of Scientific Interest in County Wexford. The National Institute for Physical Planning and Construction Research. National Parks and Wildlife Service.

- Government Office for Science (GoS) (2004). UK Foresight Programme [online]. Available from www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/index.htm [Accessed 12 Nov 2007].

- GSI and MI (2006). INFOMAR programme 2007-2013, ***Geological Survey Ireland and Marine Institute.***

- GSI (2006). Irish National Seabed Survey, ***Geological Survey Ireland***.

- GSI (2007). INFOMAR - Mapping the Irish Seabed, ***Geological Survey Ireland.*** Available from www.gsiseabed.ie.

- Gubbay, S, (2006). A review of marine aggregate extraction 1970-2005, The Crown Estate. Available from http://www.thecrownestate.co.uk/1401_sue_gubbay_report.pdf.

- Hession, C., Guiry, M. D., McGarvey, S. and Joyce. D. (1998). Mapping and assessment of the seaweed resources (***Ascophyllum nodosum, Laminaria*** spp.) off the west coast of Ireland. ***Marine Resources Series 5.*** 1-74***.*** Available from http://www.irishseaweed.com/documents/Biomass%20Repoprt%20Scropt.pdf.

- Hiscock, K. and Kimmance, S. (2003). Review of current and historical time-series seabed biological studies in the UK and near Europe. ***Marine Biological Association to the Joint Nature Conservation Committee.*** JNCC Contract: F90-01-563.

- Hiscock, K., Langmead, O. and Warwick, R. (2004). Identification of seabed indicator species from time-series and other studies to support implementation of the EU Habitats and Water Framework Directives. Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association. ***Plymouth: Marine Biological Association***. JNCC Contract F90-01-705. 109.

- Hiscock, K., Langmead, O., Warwick, R. and Smith, A. (2005a). Identification of seabed indicator species to support implementation of the EU Habitats and Water Framework Directives. Second edition. Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association. ***Plymouth: Marine Biological Association***. JNCC Contract F90-01-705. 77.

- Hiscock, K., Smith, A., Jenknins, S., Hawkins, S. and Sewell, J. (2005b). Development of a hard substratum Benthic invertebrate Water Framework Directive compliant classification tool. Environment Agency and the Joint Nature Conservation Committee from the Marine Biological Association. ***Plymouth: Marine Biological Association***. JNCC Contract F90-01-790. 41pp.

- Hiscock, K., Tyler-Walters, H. & Jones, H. (2002). High Level Environmental Screening Study for Offshore Wind Farm Developments – Marine Habitats and Species Project. Report from the Marine Biological Association to The Department of Trade and Industry New & Renewable Energy Programme. AEA Technology, Environment Contract: W/35/00632/00/00.

- Holland, C.H. (ed) (1981). A geology of Ireland. ***Scottish Academic Press, Edinburgh***. Available from http://www.cfb.ie/fisheries_research/estuaries/drongawn.htm.

- ICES (2008). ICES Shellfisheries Guidance 1998-2007 [online]. Available from www.ices.dk [accessed 08 April 2008].

- Igoe, F., Quigley, D.T.G., Marnell, F., Meskell, E., O'Connor, W. and Byrne, C. (2004). The sea lamprey ***Petromyzon Marinus (L.)***, river lamprey ***Lampetra Fluviatilis (L.)*** and brook lamprey ***Lampreta Planeri (Bloch)*** in Ireland: general biology and environment, ***Proceedings of the Royal Irish Academy***. **104B**(3), 43-56.

- Individual County Development Plans, List of Country Development Plans consulted for population estimates and general coastal development plans: Kerry, Meath, Wexford, Wicklow, South Dublin, Louth, Leitrim, Sligo, Mayo, Galway, Clare, Limerick, Waterford.

- IMDO (2004). Irish Short-Sea Shipping report [online]. Available from www.imdo.ie/. [Accessed on 19 Sept 2007].

- INSPIRE (2007). Infrastructure for Spatial Information in Europe, European Union, Inspire Directive 2007/2/EC. Available from http://www.ec-gis.org/inspire/index.cfm.

- Interreg (2001). Assessment of Human Activity in the Coastal Zone, A research project linking Ireland and Wales, Interreg Report No. 9.

- Interreg (2001). Assessment of Human Activity in the Coastal Zone, A research project linking Ireland and Wales, Interreg Report No. IM06_1_WP4.

- Interreg (2006). IMAGIN - Irish Marine Aggregates Initiative, INTERREG IIIA. Available from www.imagin-eu.org. [Accessed on 18 Jan 2008].

- IPPC (2007). Fourth Assessment Report, Climate Change 2007: Synthesis Report. Available from http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

- IPPC (2007). Intergovernmental Panel on Climate Change [online]. Available from www.ippc.ch. [Accessed on 06 Dec 2007].

- Irish Maritime Development Office (2008). IMDO Ireland, Marine Institute website [online]. Available from www.imdo.ie/main.htm. [Accessed on 24 Jan 2008].

- ISO 19115:2003 Information technology: Geographic information – Metadata, International Standards Authority.

- ISO/IEC 11179:2004 Information technology — Metadata registries (MDR), International Standards Authority.

- John Magnan and Associates (2004). The Strategic Necessity for New Port Development, ***Drogheda Port Company.***

- Jones, L. A., Hiscock, K. and Connor, D. W. (2001). Marine habitat reviews - A summary of ecological requirements and sensitivity characteristics for the conservation and management of marine SACs. ***Peterborough: Joint Nature Conservation Committee.***

- Kabuta B & Enserink L 2007, Synergies In Assessment and Monitoring (SIAM) (between OSPAR and EU Directives): national and international implementation, Rijkswaterstaat cited in HARBASINS, 2007, Recommendations on the harmonization of the implementation of the Water Framework Directive and related EU Directives. Interreg IIIB HARBASINS conference, 13 – 15 November 2007, Hull. National Institute for Coastal and Marine Management, Report No 9S8382

- Kirk McClure Morton (1996). Drogheda Port Development: Proposed Port Development at Tom Roe's Point, Environmental Impact Statement. ***Drogheda Port Company***. No. 604.

- Kirk McClure Morton (1997). Drogheda Port Development Capital Dredging Scheme: Environmental Impact Statement. ***Drogheda Port Company***. No. 840.

- Lyons D. O. (2004) Summary of National Parks & Wildlife Service surveys for common (harbour) seals (***Phoca vitulina***) and grey seals (***Halichoerus grypus***), 1978 to 2003. ***Irish Wildlife Manuals***, No. 13. National Parks & Wildlife Service, Department of Environment, Heritage and Local Governement. Dublin, Ireland.

- MacGowan, F. (2002). Overgrazing, cutting and trampling and their effects on the ecology of bogs [online]. Available from http://www.ipcc.ie/infoeffectsbogecology.html. [Accessed on 29 Jan 2008].

- Marine Aggregate Levy Sustainable Fund (2007). Marine Aggregate Dredging: Helping to determine good practice.

- Marine Institute (2005). A development strategy for marine leisure infrastructure Marine Institute.

- Marine Institute (2005). Landscape reports: Lonehort Point, Bear Island, Co. Cork, Marine Institute.

- Marine Institute (Draft) (2006). Transitional and Coastal Monitoring for the WFD. A draft implementation programme, staff requirements and costings. Marine Institute.

- Marine Institute (2006). Sea Change: A Marine Knowledge, Research and Innovation Strategy for Ireland 2007-2013, Marine Institute, Galway, Ireland.

- Marine Institute (2006). Status of Irish Aquaculture 2005, Department of Communications, Marine and Natural Resources.

- Marine Institute (2007). Status of Irish Aquaculture 2006, Department of Agriculture Fisheries and Food.

- Martin, D., Bertasi, F., Colangelo, M. A., de Vries, M., Frost, M., Hawkins, S. J., Macpherson, E., Moschella, P. S., Paola Satta, M., Thompson, R. C. and Ceccherelli, V. U. (2005). Ecological impact of coastal defence structures on sediment and mobile fauna: Evaluating and forecasting consequences of unavoidable modifications of native habitats. ***Coastal Engineering***. **52**, 1027-1051.

- Minchin, D. and Duggan, E. (1986). Organotin contamination in Irish Waters, ***International Council for the Exploration of the Sea***, **48**.1-8.

- Moore, H. B. and Kitching, M. A. (1939). The biology of ***Chthamalus Stellatus*** (Poli). ***National Marine Biological Library***. 521-541. Available from http://sabella.mba.ac.uk/1018/01/The_biology_of_Chthamalus_stellatus_(Poli).pdf

- Neiland, S. & McMahon, T. (1999). A Benthic Survey of Inner Bantry Bay, Fisheries Bulletin No. 18. Available from Benthic Survey - Bantry Bay.pdf.

- Northern Regional Fisheries Board (2007). The River Duff (or Bunduff), NRFB [online]. Available from http://www.nrfb.ie/fishing/salmon/duff.htm. [Accessed on 12 Mar 2008].

- Otte, M, L., (Ed.). (2003). Wetlands of Ireland: Distribution, Ecology and Economic Value. ***University College Dublin Press.***

- OPW (2006). OPW Planning guidelines for flooding [online]. Available from www.flooding.ie/planning/. [Accessed on 03 June 2008].

- Paipai, E. (1999). Guidelines for Port Environmental Management. DETR, Report SR-554.

- Ramsar Sites Information Service (2008). [online] Available from www.wetlands.org/RSDB [Accessed on 12 Jan 2008].

- Roe, J. and Merne, O. J. (2006). The Ecology of Blackrock: An Ecological Survey of Blackrock, Co. ***Louth. Blackrock Tidy Towns Committee.***

- Rogers S, Allen J, Balson P, Boyle R, Burden D, Connor D, Elliot M, Webster M, Reker J, Mills C, O'Connor B & Pearson S, 2003 Typology of the Transitional and Coastal Waters for the UK and Ireland, SNIFFER WFD07 (230/8030).

- RPA (2004). CEA and Developing a Methodology for Assessing Disproportionate Costs - Final report and annexes. DEFRA.

- RPS Consulting Engineers (2006). Bantry Inner Harbour Development Proposals. Murnane & O'Shea Ltd.

- RSPB and CIWEM (2005). The Saltmarsh Creation Handbook: A Project Manager's Guide to the Creation of Saltmarsh and Intertidal Mudflat.

- SEC (Commission of European Communities), (2007). Accompanying document to the COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL 'Towards Sustainable Water Management in the European Union' First stage in the implementation of the Water Framework Directive 2000/60/EC [COM(2007) 128 final] [SEC(2007) 363].

- SEPA (2007a). Development of Hydromorphological Reference Conditions and Draft Classification Scheme for transitional and coastal waters. ***Environment Agency and SNIFFER project.***

- SEPA (2007b). Draft UKTAG phase 2 Environmental Standards chapter, Assessing Morphological Alterations to Lakes and TraC water. Deported to UK – Ireland Marine Task Team.

- SFPA. (2006). Live bivalve Mollusc (Production Areas) Designation 2006. ***Sea Fisheries Protection Agency.***

- SFPA (2008). Sea-Fisheries Protection Authority [online] Available from http://www.sfpa.ie. [Accessed on 12 Jan 2008].

- Smitt., Glasson., Emillin and Hellbron. (2008). Guidelines for SEA in Marine Spatial Planning for the German Exclusive Economic Zone (EEZ) — with Special Consideration of Tiering Procedure for SEA and EIA, cited in Standards and Thresholds for Impact Assessment Vol 3, ISSN 1613-8694.

- SNIFFER (2006). Methodology to determine the effectiveness of combinations of measures for the Water Framework Directive. SNIFFER report WFD 54.

- SNIFFER (2007). Development of Hydromorphological Reference Conditions and Draft Classification Scheme for transitional and coastal waters. Environment Agency, Bristol.

- Stevens and Associates (2006). A review of relevant experience in sustainable tourism in the coastal and marine environment, Case Studies – Level 1, ***The Bantry Bay Charter, Scottish Natural Heritage.***

- Sweeney, J. (2000) A three century storm climatology for Dublin, 1715-2000, Irish Geography **33**(1), 1-14 cited in Sweeney, J., Donnelly, A., McElwain, L. and Jones, M. (2002) Climate Change: Indicators for Ireland. EPA Johnstown Castle Wexford, Ireland ERTDI Report Series No. 2.

- Sweeney, J., Brereton, T.M., Byrne, C., Charlton, R., Emblow C., Fealy, R., Howden, N., Jones, M., Donnely, A., Moore, S., Purser, P., Byrne, K., Farrell, E., Mayes, E., Minchin, D., and Wilson J. (2003). Climate Change: Scenarios & Impacts for Ireland. Environmental Protection Agency Johnstown Castle Wexford, Ireland ERTDI Report Series No. 3.

- Sweeney, J., Donnelly, A., McElwain, L. and Jones, M. (2002) Climate Change: Indicators for Ireland. EPA Johnstown Castle Wexford, Ireland ERTDI Report Series No. 2.

- SWRBD & Jacobs. (2005). Assessment of Impacts, Setting Standards and Programme of Measures (Further Characterisation) Terms of Reference for Marine Morphology.

- Twomey, E. and Mulcahy, M. F. (1998). Epizootiological aspects of a sarcoma in the cockle ***Cerastoderma edule.*** Diseases of Aquatic Organisms. **5**, 225-238.

- Tyler-Walters, H., Ager, OE.D. & Hiscock, K. (2002). Development of a marine sensitivity mapping database and GIS integration. Stage 1. Review of current habitat and species information. Report to Countryside Council for Wales from the Marine Life Information Network (MarLIN). P***lymouth: Marine Biological Association of the UK***. Contract no. FC 73-02-245.

- Tyler-Walters, H. and Hiscock, K. (2005) Impact of human activities on benthic biotopes and species. Report to Department for Environment, Food and Rural Affairs from the Marine Life Information Network (MarLIN). ***Plymouth: Marine Biological Association of the UK.***

- UCC (2000). Bantry Bay Charter Life Project, ***EU Life Programme*** [online]. Available from http://bantrybaycharter.ucc.ie/home.htm. [Accessed on 12 Mar 2008].

- WASA, (1998). Changing waves and storms in the Northeast Atlantic. Bull. Amer. Met. Soc. **79**, 741-760.

- Weinstein, M. and Reed, D. (2005). Sustainable coastal development: The dual mandate and a recommendation for 'commerce managed areas'. Restoration Ecology 13/1. 174-182.

- Went, A. (1974). Some interesting fishes taken from Irish waters in 1973. ***Irish Naturalists'***