

**NS 2 FRESHWATER PEARL MUSSEL SUB-BASIN
MANAGEMENT PLANS**

**REPORT ON MORPHOLOGICAL MONITORING AND
CATCHMENT WALKOVER RISK ASSESSMENTS IN THE
ESKE CATCHMENT**

September 2009

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INTRODUCTION

In order to assess the hydromorphological alterations within the Eske catchment the EPA WFD classification tool called the River Hydromorphology Assessment Technique (RHAT) was utilised by RPS. This tool was developed through the North South Share project, to classify rivers in terms of their morphology. It is a field technique which assigns a channel typology. This influences the rivers physical attributes assessed in the field. The technique assigns a morphological classification directly related to that of the WFD – high, good, moderate, poor and bad.

RHAT surveys were carried out at high risk areas located within pearl mussel populations. The methodology classifies river hydromorphology based on a departure from naturalness, and assigns a morphological classification, based on semi-quantitative criteria. It is designed to be a rapid visual assessment based on information from desktop studies, using GIS data, aerial photography, historical data and data obtained from previous field surveys as well as observations in the field.

A catchment walkover risk assessment survey sheet was also designed by the project team in conjunction with NPWS in order to focus the collation of the pressure data in the field with respect to the Freshwater Pearl Mussel. The risk sheet was divided into eight categories designed to highlight the main pressures within the catchment. The eight categories are as follows:

- Source of erosion
- Diffuse Nutrient
- Diffuse Silt
- Current Riparian Zone
- Field Drainage
- Outfalls
- Abstractions
- Barriers to Migration

Each sub-pressure within the eight categories is analysed and an overall risk assessment of High, Medium or Low is assigned to that category. The “one out all out principle” is then used to assign the river stretch or point an overall risk category. A detailed description, together with a series of photographs outlining the pressures is also taken. The risk assessment sheets will assist the project team in focussing the specific freshwater pearl mussel measures within the catchment.

Location of survey stretches and points are shown in Figure 1

2.0 METHODOLOGY

Sampling was carried out on the 14th May 2009.

2.1 RIVER HYDROMORPHOLOGY ASSESSMENT TECHNIQUE (RHAT)

Classification of hydromorphology can be used to contribute to the status classification of water bodies at high ecological status only. However, RHAT plays a vital role in identifying why a water body might be failing to achieve Good Ecological Status as it is based on the observed impact in the field. It can assist in deciding what indirect and direct efforts are needed to improve status and in helping to prevent further deterioration.

The eight criteria that are scored are:

1. Channel morphology and flow types
2. Channel vegetation
3. Substrate diversity and embeddedness
4. Channel flow status
5. Bank and bank top stability
6. Bank and bank top vegetation
7. Riparian land use
8. Floodplain connectivity

Sheet 1 of the RHAT form contains the Field Health and Safety sheet which is filled on arrival at the site. Before the field survey, a desk study is required this element of the survey was completed as part of the development of the draft sub-basin management plans. The reach identification and physical characterisation sections for each field site are recorded on Sheet 2 (see Appendix 1) with all information available from GIS and aerial photographs, including:

- a. expected stream type and the description of various stream types
- b. catchment and reach-scale pressures (these may help to identify, confirm or explain field observations);
- c. expected riparian vegetation types (for high quality status);
- d. the weather conditions on the day of the survey, and those immediately preceding the day of the survey. This information is important to interpret the effects of storm events on the survey results;
- e. the estimated stream width and the reach length to be assessed (~ 40 x width).
- f. any other notable issues (e.g. from previous surveys).

A score is allocated to each relevant attribute (the number of attributes to be assessed will depend on the stream type). Where the condition departs from the reference condition, note should be made if this condition results from a particular identifiable pressure. Where possible and where relevant, all attributes should be included in the assessment, using the assessment sheet (Sheet 3, see Appendix 1). If an attribute is not assessed, the score-summary table should be amended (cells shaded) and a note made as to why the assessment was not carried out. The WFD status can still be calculated on the basis of other attributes, but with a note that a particular attribute was omitted.

Transfer scores for individual attributes to the summary table on the survey Sheet 2.

Finally the overall WFD category can be calculated using the following values:

> 0.8	= high
0.6 – 0.8	= good
0.4 – 0.6	= moderate
0.2 – 0.4	= poor
< 0.2	= bad

For the purposes of the assessment as part of the NS2 project, a high status for morphology is desirable for pearl mussel habitats. Through work carried out by the Shannon IRBD project on the Freshwater Morphology Programme of Measures Study, it was found that an observed relationship exists between biological data and a RHAT score. The study confirmed that morphological pressure can impact biology and therefore ecological status. In general, sites with RHAT scores less than 0.6 also have less than good Q scores. Similarly high levels of siltation affecting macrophyte populations are reflected by less than good RHAT scores.

Grid references were recorded at all sites using a GPS together with site photographs which were taken using a digital camera.

2.2 CATCHMENT WALKOVER RISK ASSESSMENT

During the development of the draft sub-basin management plans throughout 2008 a complete desk study was conducted of all relevant biological, water quality and pressure source data within the Eske catchment. Best use was made of all available datasets such as the pressure source data collated by the River Basin District Projects for the Article V Characterisation and Programme of Measures Studies. This work allowed the NS 2 project team to assess the catchment through the combined availability of aerial imagery and digitised pressure information. Where gaps in this data existed together with areas that required ground truthing such as physical barriers to migration, catchment walkover risk assessments were focussed throughout the 2009 field survey season.

The catchment walkover risk assessment sheet (See Appendix 3) covers eight main categories or pressures which are subsequently sub-divided into the various sources. Each source is ticked if present and an overall risk assessment for each pressure assigned from High to Medium to Low over the survey length or point. All eight pressures are combined to give an overall risk assessment to the catchment based on the “one out all out principle”.

3.0 RESULTS

Figure 3.1 indicates where the Eske morphology RHAT assessments were carried out throughout the catchment.

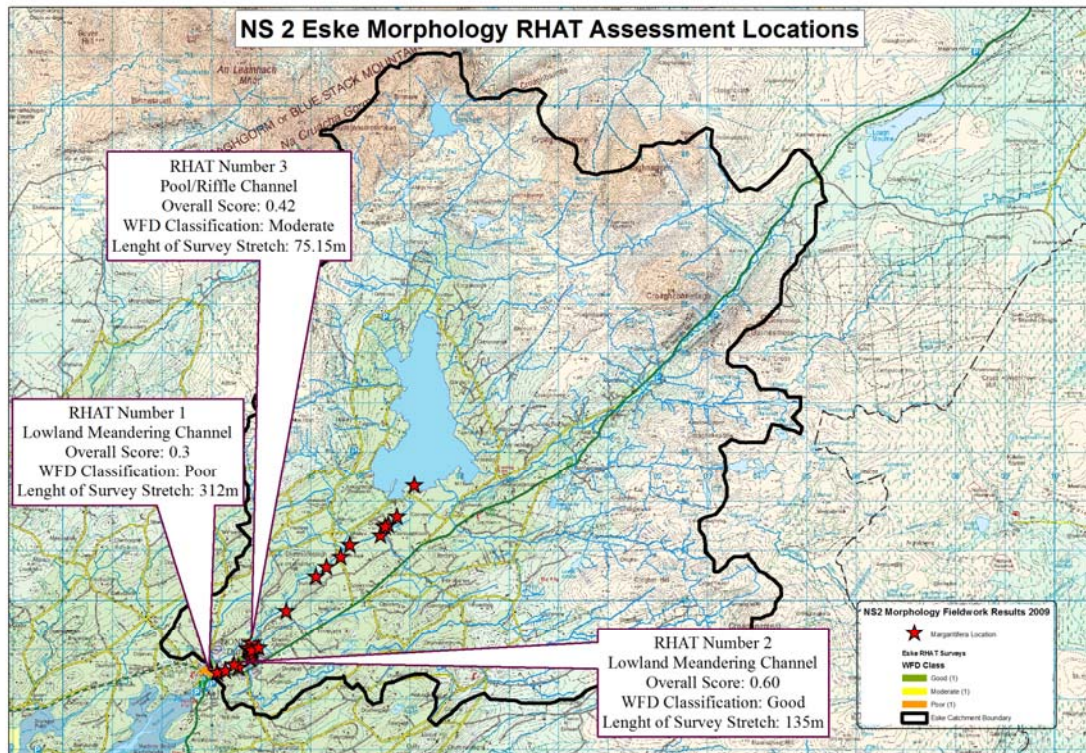


Figure 3.1 Morphology RHAT Assessment Locations

(The RHAT numbering system corresponds to the site code which may mean they are not sequential where a RHAT was not carried out at a particular site)

3.1 RHAT Survey Results

Three RHAT surveys were carried out throughout the Eske catchment. The results of these surveys can be found in the electronic appendix. One each at moderate, poor and bad status. RHAT number 1 was carried out in the vicinity of Donegal Town at the lower end of the catchment and was classified as being at Poor status. These stretch is largely urbanised with flood walls, culverts/outfalls and some resectioning, reinforcement and embankments found along both banks and in excessive lengths (i.e. >30%). All attributes scored low except for barriers to migration which scored three out of four. Due to the extensive artificial banks which have altered the flow and channel form and led to the removal of the bank side vegetation these attributes all scored one out of four. The Bank structure and stability together with the floodplain connectivity







scored zero (bad) again due to the total artificial nature. Overall, this stretch is in poor condition from a morphological point of view with three major bridges, mid-channel bars, deflectors, storm water outfalls and culverts along the stretch.

RHAT Number 2 was carried out further upstream from RHAT number 1. Drainage works, land improvement together with re-seeding and associated fertilisation coincided with extensive *Ranunculus* growth in the channel. Some resectioning and excessive reinforcement (>30%) was recorded on the left bank. The Channel vegetation, substrate condition, bank vegetation, riparian landcover and floodplain connectivity all scored two out of four. It is a lowland meandering channel and while it is classified as being at “Good” status this is a borderline score and it could well be downgraded to moderate status.

RHAT number 3 scored well on all attributes except substrate condition, bank vegetation and riparian landcover. This is also as a result of the adjacent forestry plantation which has led to tunnelling and a build up of pine needles on the substrate which is blocking out light and leading to a growth of filamentous algae.

RHAT number 3 (Site 13) was carried out further upstream of Donegal Town at Eske Bridge on the N59. This is a major bridge structure with large artificial boulders placed in channel along the verges of the bridge piers. There are insufficient sustainable natural banks on either side of this bridge and as such it has led to a significant loss of habitat. The substrate has been highly altered by the bridge structure with high levels of *Ranunculus* recorded in channel. All attributes scored low except for barriers to migration which scored three out of four. Channel vegetation, substrate condition, bank structure and stability and bank vegetation all scored only one out of a possible four. Overall this stretch was classified as being at “moderate” status again as with RHAT number 2 it was only 0.02 above the hydromorph score for moderate and could be downgraded to poor status.

Plate 3.1 Representative photographs from reach:

<p>RHAT 1 Site 1</p> 	<p>RHAT 1</p> 
<p>RHAT 2</p> 	<p>RHAT 2</p> 
<p>RHAT 3 (Site 13)</p> 	<p>RHAT 3 (Site 13)</p> 

Details in relation to photographs are tabulated in Appendix 2.

3.2 Catchment Walkover Risk Assessment Results

A total of seventeen sites were surveyed in the Eske sub-basin catchment, with a risk assessment carried out at sixteen of these sites (one stopping points). **Figure 3.1** outlines the stopping point locations in addition to the High to Low Risk Assessment from the Catchment Walkover Risk Assessments. Five high risk sites were recorded out of the sixteen that were assessed. A further eight were considered medium risk, with three sites classed as low risk. **Figure 3.2** outlines the percentage of sites classified at high, medium and low risk together with the stopping point throughout the catchment.

The most common high risk categories identified were:

- Diffuse silt – evident at 60% of high risk sites,
- Field drainage – evident at 60% of high risk sites.

The Current Riparian Zone category of the Catchment Walkover Risk Assessment slightly varies from the seven other categories or pressures. The Current Riparian Zone is not a pressure in itself; however the aspects listed in this category are the interceptors to the pressure and convey the extent or lack of buffer provided by the riparian zone. A high risk riparian zone indicates that the pressures acting on the river are more likely to have significant impact. For example the lack of fencing along a river stretch can lead to excessive trampling and/or poaching which in turn may lead to siltation within a pearl mussel habitat. The various categories and pressures listed in the Catchment Walkover Risk Assessment sheet were designed to assist the project in focussing the measures which will be needed to combat the pressure along its pathway, rather than removing a source which may not always be possible such as intensive agriculture. Recording the Riparian Zone in terms of its current performance as a buffer is important in this regard.

Current Riparian Zone has ten aspects as follows:

- Fencing
- Buffer
- Tree line at bank
- Tree line buffer

- Plantation with no buffer
- Urbanisation
- Flood Protection
- Marshy Land
- Landuse at bank
- Other Sources

Where one or any of these aspects is found to be the cause of significant impact to the riparian zone, or the channel along the stretch then this category may be assigned a high risk score. Locations where pressures were evident in the field which were not highlighted through the desk based assessment were also noted as stopping points. These points were not selected prior to fieldwork, they were opportunistic as the catchment drive through was taking place. The pie chart in **Figure 3.2** indicates the percentage of stopping points also.

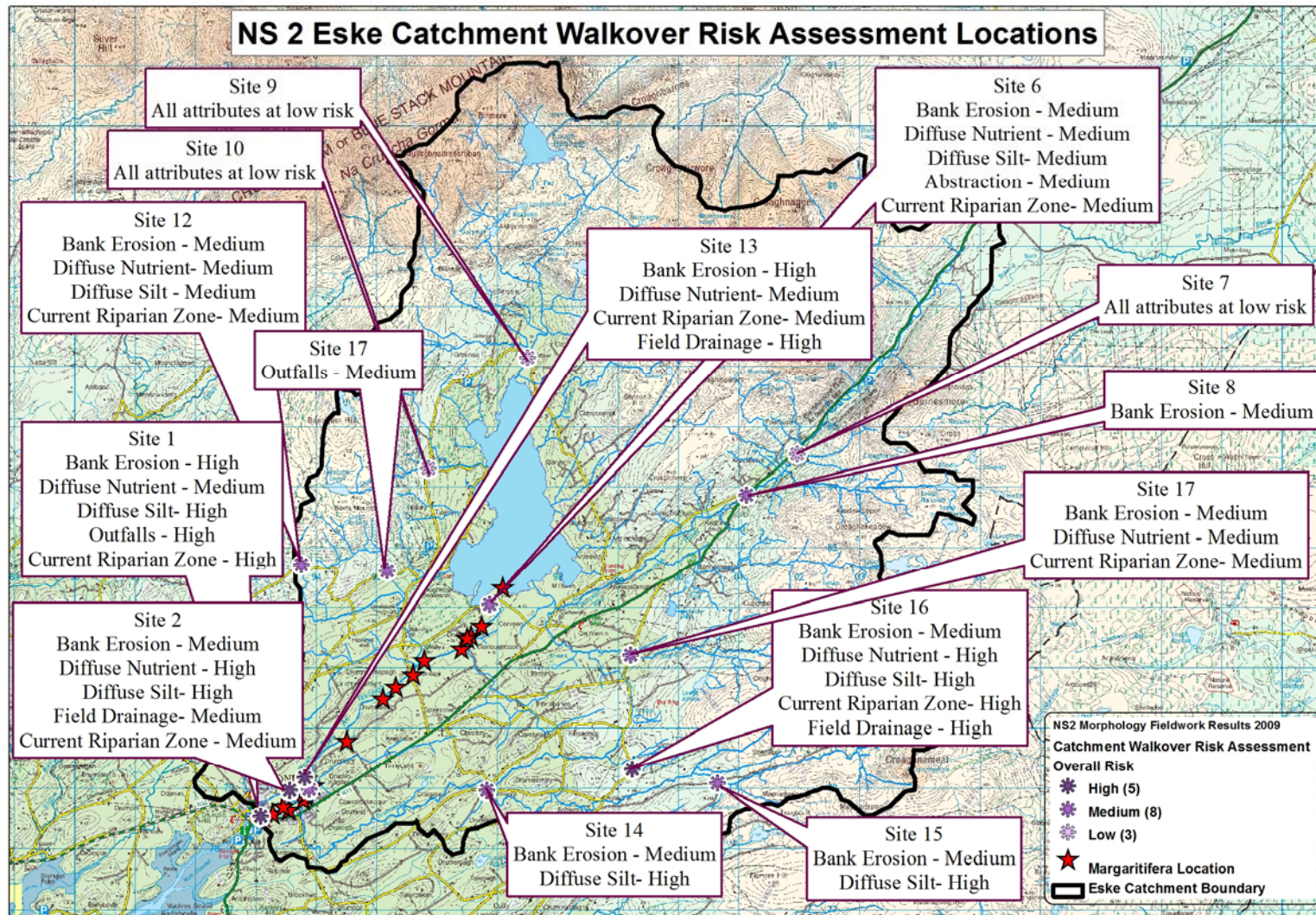
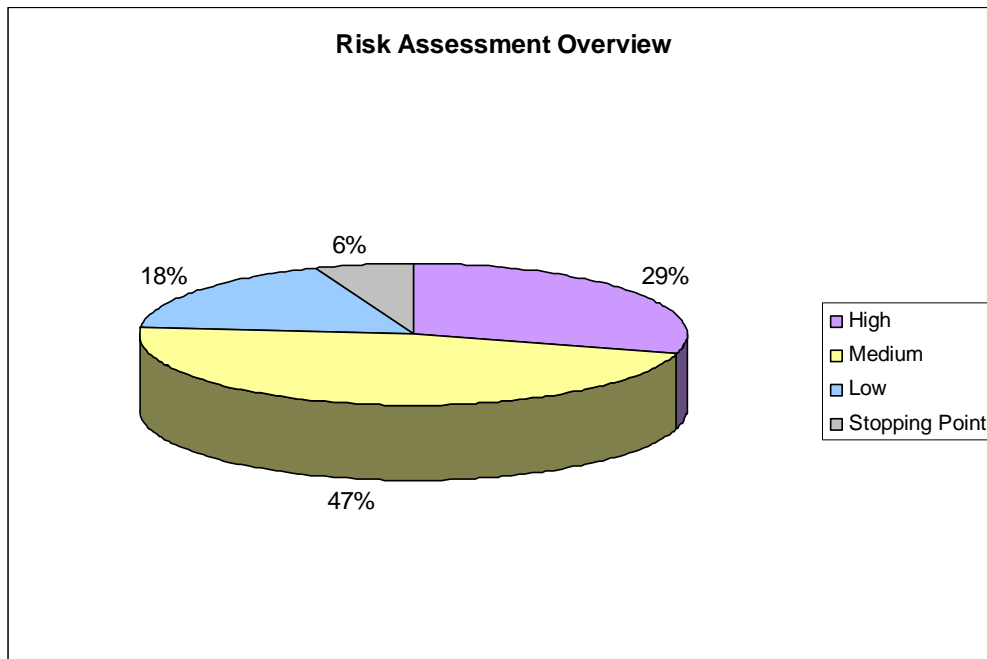


Figure 3.1 Location of Stopping points and Catchment Walkover Risk Assessments

Figure 3.2 Risk Assessment Overview



The break-down of pressure categories identified as high risk are outlined in **Figure 3.3**

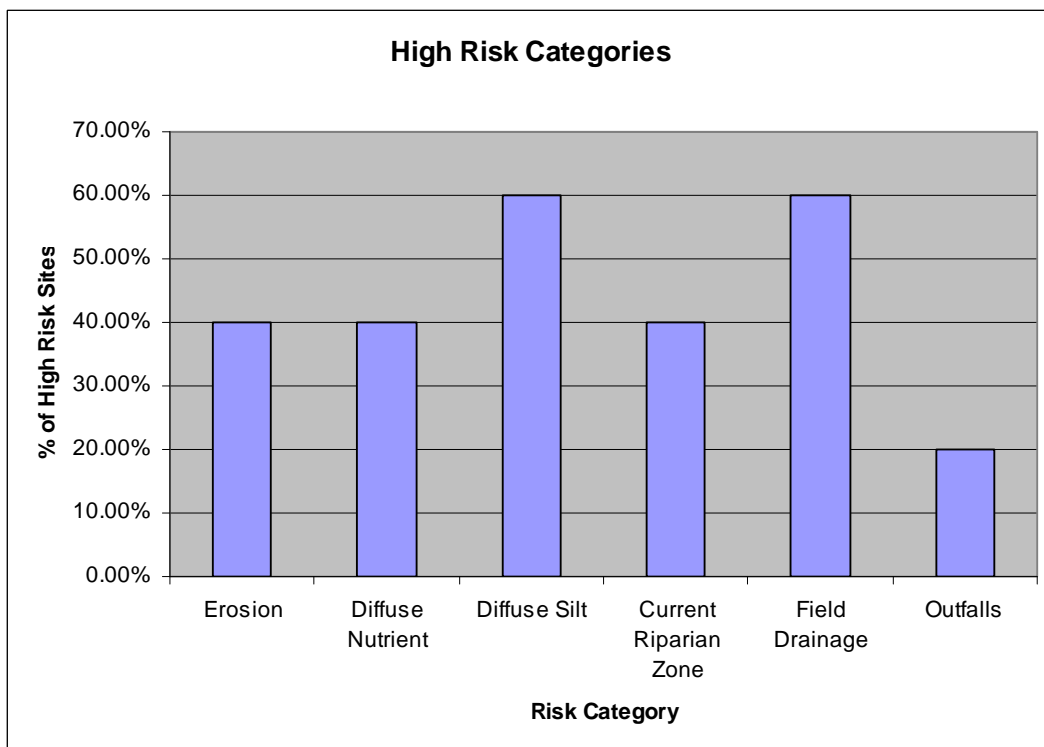
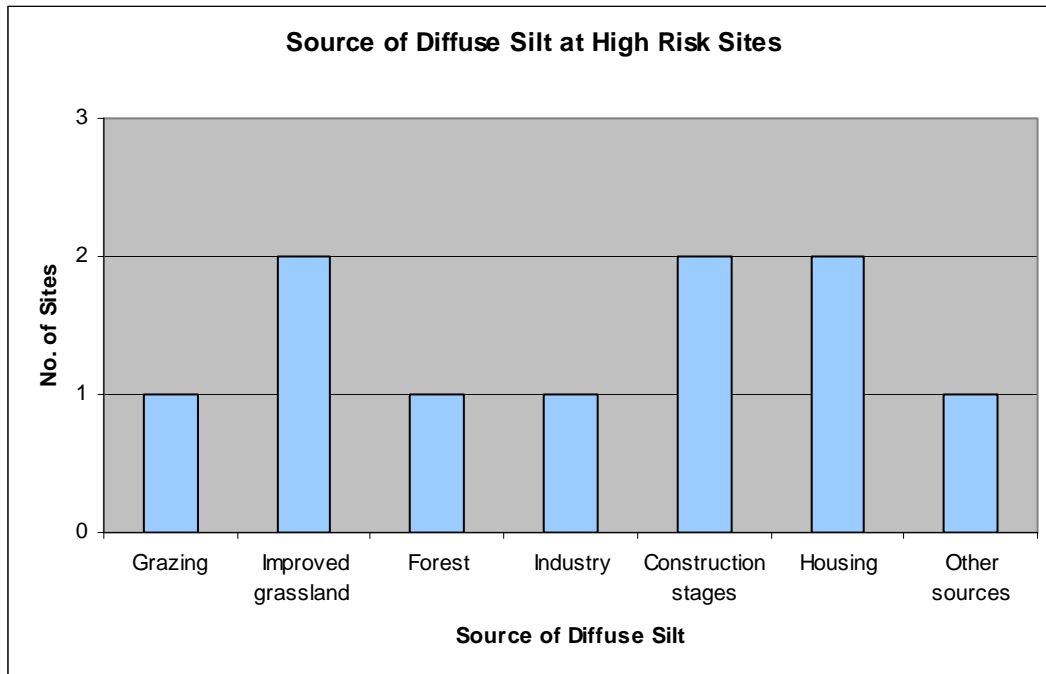


Figure 3.3 Break-down of High Risk categories

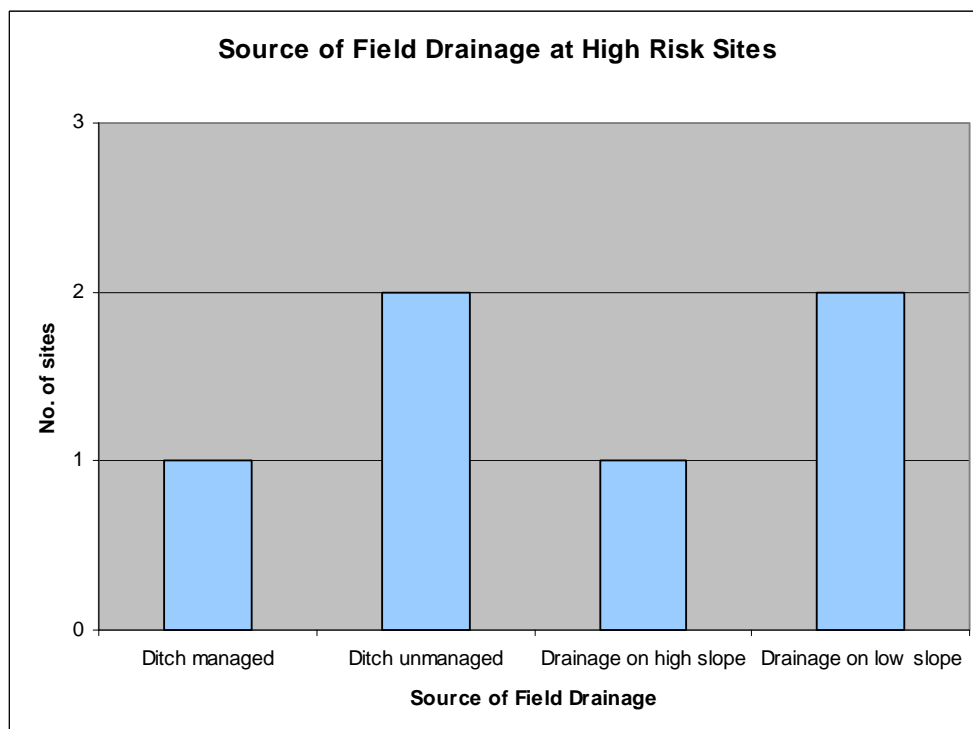
The most frequent sources of diffuse silt were improved grassland, construction stages and housing each creating a pressure at two of the five high risk sites. The remaining sources are outlined in **Figure 3.4** below.

Figure 3.4 Source of Diffuse Silt at High Risk Sites



The most common sources of field drainage were unmanaged ditches and drainage on a low slope, each high risk at two sites.

Figure 3.5 Sources of Field Drainage at High Risk Sites



3.3 Point Discharges

Point sources discharging nutrients, such as wastewater treatment plants, can contribute very significant nutrient and organic loads to rivers. Quarry dust and effluent can cause problems with silt pollution and, in some cases, lime pollution. Landfills and landfill leachate can be sources of surface and groundwater contamination that can find pathways to the river. Storm water drainage can be a source of silt and pollutants.

Two major point source pressures was observed in the catchment, Harvey's Point hotel located on the shores of Lough Eske and Solis Lough Eske Castle also located just downstream of Lough Eske in Drumnacarry. A Licence review for both point source pressures located within the catchment should be carried out as a priority.

Waste Water Treatment Plants

A review was undertaken of the available information on municipal and industrial discharges by the South Western River Basin District Project (SWRBD) and an assessment carried out as to whether any river water bodies were considered to be at risk from point sources under a number of circumstances. Within the Eske catchment we then assessed all monitoring information together with pearl mussel status above and below any WWTP and prioritised those which we deemed to have a significant adverse effect on the pearl mussel population or its habitat. Following this prioritisation process no WWTPs within the Eske catchment were deemed to have a significant adverse affect on the pearl mussel or its habitat.

Quarries

The Eske catchment also contains four quarries which are adjacent to river stretches in the head waters of the catchment along the Lowerymore River as per **Figure 3.6**. Due to their location within the catchment they are not seen as a direct risk to the Freshwater Pearl Mussel populations however any future developments to these quarries or the locating of future quarries within the catchment would require an Appropriate Assessment for Natura 2000 sites.

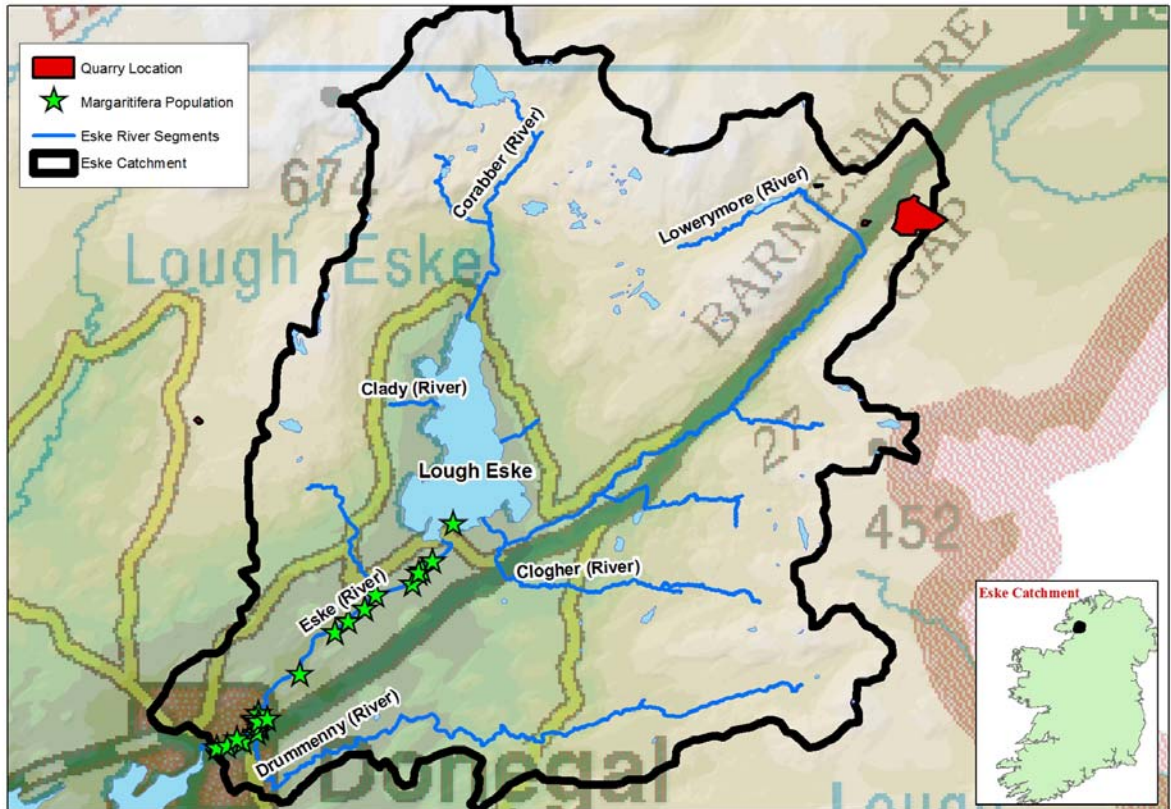


Figure 3.6 Location of Quarries within and adjacent to the Eske Catchment

The pressures outlined above all have the ability to negatively affect the status of the freshwater pearl mussel. In some cases, a single pressure alone may be enough to cause a kill or ongoing chronic effects, but in most cases it is the combination of the negative effects of a number of pressures that are acting together to leave the freshwater pearl mussel habitat in unfavourable condition. It is unlikely that the effect of every diffuse source of pollution can be totally removed. Therefore, it is not possible to choose a subset of pressures to act on; steps must be taken to reduce every pressure, until the cumulative effect of all the reductions is a sustainable habitat for the freshwater pearl mussel and all the other species that it protects thanks to its umbrella and keystone status in its habitat. This is the essence of the precautionary principle under which the Habitats Directive must be implemented.

4.0 CONCLUSIONS

This catchment has relatively fewer high risk sites than many other sub-basin catchments in Ireland, however it is significant that Freshwater Pearl Mussel populations have been recorded at four of the five high risk sites. A total of five sites were surveyed upstream of Lough Eske, three of these sites were low risk and two medium risk. Eleven sites were surveyed downstream of Lough Eske, The five high risk sites are located along these stretches; with the remaining six sites all considered to be medium risk. As with many of the Freshwater Pearl Mussel catchments there are significant point source pressures within this catchment which need to be addressed first.

APPENDIX A

RHAT Field Sheet

Field Health and Safety sheet

River Name _____ Site Code _____ Date _____

1 = Low risk 5 = High risk

Please circle applicable number

PARKING	1	2	3	4	5
FENCES/BARRIERS	1	2	3	4	5
GROUND STABILITY	1	2	3	4	5
DENSE VEGETATION	1	2	3	4	5
BANK STEEPNESS OR STABILITY	1	2	3	4	5
RISK FROM ANIMALS	1	2	3	4	5
PHONE COVERAGE	1	2	3	4	5

Previous RHS/RAT/RHAT surveys - year and code _____

Details of access _____

RHAT (VERSION 2)

TRIBUTARY / MAIN CHANNEL*

Site Identification

River Name _____ Site Code _____

Nearest WFD site FF10 _____

Water Body ID _____ Start U / S or D / S*

First IGR _____ Last IGR _____

Bank surveyed from L / R / Both / in-Channel*

Desk-study notes	Field Notes						
<p>ACTION TO TAKE PRIOR TO FIELDWORK</p> <p>General overall shape of river Check weirs, impoundments etc. on catchment</p>	<p>River type</p> <p>Date</p>						
<p>Floodplain connectivity and land use</p> <p>Expected river type</p> <p>Rain last week</p> <p>Estimated river width</p> <p>Estimated survey length</p> <p>Riparian land cover(s)</p> <p>River Agency designated?</p> <p>Other comments including geology - limestone / siliceous / peat*</p>	<p>Time</p> <p>Surveyors</p> <p>Weather conditions now</p> <p>Estimated river width (m) (average 3 readings)</p> <p>Estimated survey length (m) (40 X wetted width)</p> <p>Estimated river depth (m)</p> <p>Channel characteristics (e.g. different stream types on the reach)</p>						
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 2px;">RESULTS</td> <td style="width: 70%;"></td> </tr> <tr> <td style="padding: 2px;">Hydromorph score</td> <td></td> </tr> <tr> <td style="padding: 2px;">WFD class</td> <td></td> </tr> </table>	RESULTS		Hydromorph score		WFD class		<p>Pressures</p>
RESULTS							
Hydromorph score							
WFD class							
<p>*Circle as appropriate</p>							

Photograph details include IGR or approximate location

N.B. The survey length should be 40x the wetted width with a minimal stretch of 160m but not exceeding 1km.

NS RHAT

Anthropogenic Impacts

River Name _____ Site Code _____ Date _____

Feature	Tick if present, record as E if > 30%
Resectioning	None <input type="checkbox"/> Left bank <input type="checkbox"/> Right bank <input type="checkbox"/>
Reinforcement	None <input type="checkbox"/> Left bank <input type="checkbox"/> Right bank <input type="checkbox"/>
Embankments NO*	LB <input type="checkbox"/> RB <input type="checkbox"/> Set back LB <input type="checkbox"/> SB RB <input type="checkbox"/>
Culverts**	Y / N / Unknown*
Over deepening	Y / N / Unknown*
Wver widened	Y / N / Unknown*
Narrowing	Y / N / Unknown*
Fords**	Y / N*
	Major / Intermediate / Minor
Bridges** NO*	
Weirs** NO*	
Fish Pass** NO*	

Physical features or resource use if applicable. *

Deflectors / Jetties / Arterial drainage / Side channels / Mid channel bar / Field Drains / Mill Race

Navigation / Fishing / Recreation / Forestry/ Urban / Industry / HEP

Trashline present (height __ m) above water / Buffer zone (LBm / RBm back from water edge)

Other observations - Invasives - Trees - Birds - Pollution indicators - Invertebrates*

Rhododendron / Himalayan Balsam / Japanese Knotweed / Giant hogweed / Snowberry / Cherry-Laurel/ Gunnera

Sycamore / Beech / Conifers / Oak / Ash / Alder / Willow / Birch / Hazel / Hawthorn / Blackthorn / Holly

Heron / Sand martin / Grey wagtail / Dippers / Kingfishers /

Sewage fungus / Diatomaceous algae / Oil / Cladophora / Vaucheria / Dumping / Silt on Substrate

Other comments:

* Circle as appropriate E - extensive. ** Tally as appropriate. LB - left bank / RB - right bank

RHAT RIVER HYDROMORPHOLOGY ASSESSMENT TECHNIQUE

Field Assessment of Morphological Condition

River Name _____ Site Code _____ Date _____

If river in spate ignore 3 and 4 but deduct individual scores from overall if either feature not visible. Greyed boxes may be scored but note why in Comments/Notes.

	Bedrock	Cascade / Step-pool	Pool-riffle-glide	Lowland Meandering
1. Channel form and flow types	4	4	4	4
2. Channel vegetation	4	4	4	4
3. Substrate condition	4	4	4	4
4. Barriers to continuity	4	4	4	4
5. Bank structure & stability L+R	4	4	4	4
6. Bank vegetation L+R	4	4	4	4
7. Riparian land cover L+R	4	4	4	4
8. Floodplain connectivity L+R	4	4	4	4
TOTAL	32	32	32	32
Hydromorph Score *				
WFD class **				

* Hydromorph score - Assessment score = Maximum Possible score

** WFD Class

> 0.8 = high

>0.6 - 0.8 = good

>0.4 - 0.6 = moderate

>0.2 - 0.4 = poor

< 0.2 = bad.

SHEET 5

NOTES

APPENDIX 2

PHOTOGRAPHS

Photographs of site locations and catchment pressures on the Eske River and tributaries 2009. All field work photographs can be found in the accompanying electronic appendix.

Overall Risk * uses the “one out all out” principle

Site No.	Catchment Name	Location	X	Y	Photo No.	Bank Erosion	Diffuse Nutrient	Diffuse Silt	Field Drainage	Outfalls	Abstraction	Barriers to Migration	Current Riparian Zone	Overall Risk*	Pressure/Photo Details
1	Eske	Donegal Town Centre	193085	378546		High	Medium	High	Low	High	Low	Low	High	High	Walled River Through Town and road either side of river. Trees present
2	Eske		193560	378965		Medium	High	High	Medium	Low	Low	Low	Medium	High	Soccer Pitch on Left Bank with improved grassland
3	Eske		193886	378986		Medium	Low	Low	Low	Medium	Low	Low	Low	Medium	Bridge pier causing erosion and deposition. Angling path. Rannunclus present.
4	Eske														
5	Eske					Medium	Low	Low	High	Low	Low	Low	Medium	High	V-Notch weirs present. Walkway for anglers. Heavy siltation.
6	Eske	Lough Eske	196876	382053		Medium	Medium	Medium	Medium	Low	Medium	Low	Medium	Medium	Improved Grass on Right Bank. House on Left Bank (septic tank). Tree line buffer 5m both sides. V-notch weirs and unknown structure on Left bank.
7	Eske	Biddy's	201968	384547		Low	Low	Low	Low	Low	Low	Low	Low	Low	Picnic area buffer below pub. N15 30m back. Rough grazing, woodland, heath bog

8	Eske	Lowrey More	201133	383871		Medium	Low	Low	Low	Low	Low	Low	Low	Medium	Overgrown scrub. Erosion from road bridge. Boulders as hardbank. Grass verge at road 50m from road left bank.
9	Eske	Coprabe Bridge	197499	386156		Low	Low	Low	Low	Low	Low	Low	Low	Low	Overgrown scrub/trees. Rough grazing beyond heath bog. Natural bedrock as a barrier to migration
10	Eske	Clady Bridge	195859	384315		Low	Low	Low	Low	Low	Low	Low	Low	Low	Woodland, scrub, mountain heath, bedrock channel. Natural barriers to migration present. Forest further u/s
11	Eske		195179	382612		Low	Low	Low	Low	Medium	Low	Low	Low	Medium	Road/storm drainage. Natural barriers present and step pool cascade.
12	Eske		193759	382714		Medium	Medium	Medium	Low	Low	Low	Low	Medium	Medium	1st order stream. Fencing poor on right bank. Rough grazing
13	Eske	New Bridge	193806	379181		High	Medium	Low	High	Low	Low	Low	Medium	High	Dead FWPM shell (4cm). Footpath either side of river. Excessive inflow drainage on right bank. Located under new road bridge. Seepage

															from surrounding fields (Septic Tanks)
14	Eske		196825	378966		Medium	Low	Medium	Low	Low	Low	Low	Low	Medium	Tractor tracks to waters edge (silt). Fencing on left bank and rough grazing both sides of river.
15	Eske	Drummenny River	200652	379087		Medium	Medium	Low	Low	Low	Low	Low	Medium	Medium	IS up to bank. No bank structure. Small areas of IS but not intensively improved. Tree line d/s of bridge. No buffer elsewhere.
16	Eske		199237	379319		Medium	High	High	High	Low	Low	Low	High	High	Improved grassland with no buffer. 1st Order stream
17	Eske	Clogher Bridge	199207	381208		Medium	Medium	Low	Low	Low	Low	Low	Medium	Medium	Loose hardcore present. Bare bank access u/s and d/s. Septic tanks from houses. Trees d/s. Trib entry.

Appendix 3 – Catchment Walkover Risk Assessment Survey Sheet

	Present?		Grid Reference of specific pressure	No. of Photographs	Comments
	Yes	No			
Source of Erosion					
Bank erosion					
Land clearance					
In river clearance					
Arable ploughing					
Animal trampling					
Fords					
Channel manipulation					
Hard bank protection measures					
Other sources					
Overall Risk	High	Medium	Low		
Diffuse Nutrient					
Arable					
Grazing					
Improved grassland					
Slilage					
Forestry					
Housing					
Industry and associated works					
Other sources					
Overall Risk	High	Medium	Low		
Diffuse Silt					
Arable					
Grazing					
Over-grazing					
Improved grassland (Re-seeding)					
Forest					
Slilage					
Industry					
Construction stages					
Housing					
Infilling					
Peat cutting					
Quarries					
Other sources					
Overall Risk	High	Medium	Low		

	Present?		Grid Reference of specific pressure	No. of Photographs	Comments
	Yes	No			
Current Riparian Zone					
Fencing					
Buffer					
Tree line at bank					
Tree line buffer					
Plantation with no buffer					
Urbanisation					
Flood protection					
Marshy land					
Landuse at bank					
Other sources					
Overall Risk	High	Medium	Low		
Field Drainage					
Ditch managed					
Ditch unmanaged					
Drainage on high slope					
Drainage on low slope					
Land drainage (perforated pipes)					
Other sources					
Overall Risk	High	Medium	Low		
Outfalls					
Industrial discharges					
Storm drains					
Culvert outfalls					
Other sources					
Overall Risk	High	Medium	Low		
Abstractions					
Small					
Large					
Overall Risk	High	Medium	Low		
Barriers to migration					
Culverts					
Bridge aprons					
Weirs					
Stone weirs					
Other sources					
Overall Risk	High	Medium	Low		