Our Case Number: ABP-318446-23

Planning Authority Reference Number:

An Bord Pleanála

Peter Sweetman and Associates
PO Box 13611
Bantry
Co. Cork

Date: 30 January 2024

Re: Proposed construction of Coumnagappul Wind Farm consisting of 10 no. turbines and associated infrastructure.
In the townlands of Coumnagappul, Carrigbrack, Knockavanniamountain, Barricreemountain Upper and Glennaneanemountain, Skeehans, Lagg, Co. Waterford.
(www.coumnagappulwindfarmSID.ie)

Dear Sir / Madam,

An Bord Pleanála has received your recent submission in relation to the above mentioned proposed development and will take it into consideration in its determination of the matter. Please accept this letter as a receipt for the fee of €50 that you have paid.

The Board will revert to you in due course with regard to the matter.

Please be advised that copies of all submissions / observations received in relation to the application will be made available for public inspection at the offices of the local authority and at the offices of An Bord Pleanála when they have been processed by the Board.

More detailed information in relation to strategic infrastructure development can be viewed on the Board's website: www.pleanala.ie.

If you have any queries in the meantime, please contact the undersigned officer of the Board or email sids@pleanala.ie quoting the above mentioned An Bord Pleanála reference number in any correspondence with the Board.

Yours faithfully,

pp HCM

Niamh Hickey
Executive Officer
Direct Line: 01-8737145

PA04

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24. SUBMISSION RE PA93.318446

REG.NO.	PA93.318446
DESCRIPTION	Proposed construction of Coumnagappul Wind Farm consisting of 10 no. turbines and associated infrastructure.
ADDRESS	In the townlands of Coumnagappul, Carrigbrack, Knockavanniamountain, Barricreemountain Upper and Glennaneanemountain, Skeehans, Lagg, Co. Waterford
APPLICANT	Coumnagappul Wind Farm Limited (Applicant)

An Bord Pleanála's Legal Functions.

An Bord Pleanála's has three distinct sets of legal tasks when it deals with an application such as this one.

1. The Planning Acts
2. The Environmental Impact Assessment Directive
3. The Assessment under the Habitats Directive

4. The Planning Acts

It must examine the application to ascertain if the contents of the application comply with the Planning Regulations, in particular Articles 22 and 23 of the 2001 regulations. (See Judgement of Humphries J Sweetman v An Bord Pleanála 2020 No. 557 JR)

It must assess the planning merits of Application in accordance with the **Planning and Development Act 2000** (as amended) to ensure that the proposed development is in accordance with the proper planning and sustainable development of the area.

2.The Environmental Impact Assessment Directive

An Bord Pleanála must examine the EIAR to ascertain full compliance, with particular relevance to the following.

INFORMATION REFERRED TO IN ARTICLE 4(4) (of the Directive)

1. A description of the project, including in particular:
   (a) a description of the physical characteristics of the whole project and, where relevant, of demolition works.
   (b) a description of the location of the project, with particular regard to the environmental sensitivity of geographical areas likely to be affected.

2. A description of the aspects of the environment likely to be significantly affected by the project.

3. A description of any likely significant effects, to the extent of the information available on such effects, of the project on the environment resulting from:

   (a) the expected residues and emissions and the production of waste, where relevant.

   (b) the use of natural resources, in particular soil, land, water and biodiversity.

The Board is required to form and record a view as to the environmental impacts of the development, considering the **EIA Report (EIAR)** furnished by the Applicant, the views of the public concerned and applying its own expertise.

An Bord Pleanála's is the competent authority having responsibilities under the **Habitats Directive.**

This responsibility is
1. To screen the development under Article 6.3.
2. To make a decision as required under 6.3

The legal case for screening is found in AG Sharpston in the opinion to 259/11 Sweetman & Others v An Bord Pleanála

"47. It follows that the possibility of there being a significant effect on the site will generate the need for an appropriate assessment for the purposes of Article 6(3). The requirement at this stage that the plan or project be likely to have a significant effect is thus a trigger for the obligation to carry out an appropriate assessment. There is no need to establish such an effect; it is, as Ireland observes, merely necessary to determine that there may be such an effect."

This is implemented into Irish law by Finlay Geoghegan J. in Kelly -v- An Bord Pleanála [2014] IEHC 400 (25 July 2014) at

"26. There is a dispute between the parties as to the precise obligations imposed on the Board in relation to the stage 1 screening by s.1777U but its resolution is not strictly necessary in these proceedings. There is agreement on the nature and purpose of the screening process which is well explained by Advocate General Sharpston in Case C-258/11 Sweetman at paras 47-49:

"47. It follows that the possibility of there being a significant effect on the site will generate the need for an appropriate assessment for the purposes of Article 6(3). The requirement at this stage that he plan or project be likely to have a significant effect is thus a trigger for the obligation to carry out an appropriate assessment. There is no need to establish such an effect; it is, as Ireland observes, merely necessary to determine that there may be such an effect."

This development is 0.76 km from the Comeragh Mountains SAC (001952)
The site synopsis states.
Peregrine, a species listed on Annex I of the E.U. Birds Directive, breeds within the site, as does Raven. Hen Harrier, also listed on this Annex, is found on the site, as is Irish Hare, a Red Data Book species. Arctic Char has been recorded from the Comeragh Lakes, though not since 1930. This species is listed in the Red Data Book as threatened in Ireland.
There is no mention of the Hen Harrier in the Report for AA Screening and Natura Impact Statement,
The Appropriate Assessment Screening for this development does not comply with.

> *"So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned."*

On the basis of the total lack of certainty in the information submitted it is not possible for An Bord Pleanála to make a decision to grant permission.

Potential For Adverse Effects on the Freshwater Pearl Mussel has not been assessed in compliance with the latest relevant reports.

GUIDANCE ON ASSESSMENT AND CONSTRUCTION MANAGEMENT IN MARGARITIFERA CATCHMENTS IN IRELAND
Atkinson, S., Magee, M., Moorkens, E.A. & Heavey, M. (2023). *Guidance on Assessment and Construction Management in Margaritifera Catchments in Ireland.* https://e-mussels.eu/europe/conservation-guidelines
and
SUPPLEMENTARY GUIDANCE ON ASSESSMENT AND CONSTRUCTION MANAGEMENT IN *MARGARITIFERA*CATCHMENTS IN IRELAND: BLACKWATER RIVER (CORK/WATERFORD) SAC

Atkinson, S., Magee, M., Moorkens, E.A. & Heavey, M. (2023). *Supplementary Guidance on Assessment and Construction Management in Margaritifera Catchments*

Therefore it is not possible for An Bord Pleanála to grant a permission which passes threshold as set out in 44 of CJEU Case 258/11
Judgment of the Court (Third Chamber), 11 April 2013.
Peter Sweetman and Others v An Bord Pleanála.

> *"So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned."*

This is a strict standard and An Bord Pleanála does not have legal jurisdiction to give permission if it is not met.

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Peter Sweetman

Peter Sweetman PO Box 13611 Bantry Co Cork
and of behalf of Wild Ireland Defence CLG North Allihies Beara Co. Cork
[redacted]

GUIDANCE ON ASSESSMENT AND CONSTRUCTION MANAGEMENT IN *MARGARITIFERA* CATCHMENTS IN IRELAND

S. Atkinson, M. Magee, E.A. Moorkens & M. Heavey

December 2023

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EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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Atkinson, S., Magee, M., Moorkens, E.A. & Heavey, M. (2023). *Guidance on Assessment and Construction Management in Margaritifera Catchments in Ireland.* https://e-mussels.eu/europe/conservation-guidelines

Acknowledgements:

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The authors would like to thank the many mussel, planning, construction and industry experts that generously contributed their advice.

QUICK ACCESS 1 - CONSERVATION OBJECTIVES

The table below provides general Conservation Objectives for *Margaritifera* that relate to the Site Specific Conservation Objectives that should be the basis for assessment for projects that could impact SAC *Margaritifera* Populations.

Conservation Objective	Target
Distribution	Maintain or restore distribution as per Conservation Objectives suitable habitat length
Population Size	Maintain or restore population size should be at least the equivalent to the numbers for a sustainable population listed in the Conservation Objectives
Population Structure: Recruitment	Maintain or restore at least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length
Population Structure: adult mortality	No more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution
Suitable Habitat: Extent	Maintain or restore suitable habitat across the distribution in the Conservation Objectives any additional stretches necessary for salmonid spawning
Suitable Habitat: Condition	Maintain or restore condition of suitable habitat
Water Quality: Macroinvertebrate and phytobenthos	Maintain or restore water quality: macroinvertebrates: Ecological Quality Ratio (EQR) greater than 0.90 (Q4-5, Q5); phytobenthos: EQR greater than 0.93
Substratum Quality: Filamentous Algae/Macrophytes	Maintain or restore substratum quality- filamentous algae: absent or trace (less than 5%); macrophytes: absent or trace (less than 5%)
Substratum Quality: Sediment	Maintain or restore substratum quality- stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment
Substratum Quality Oxygen availability	Maintain or restore no more than 20% decline from water column to 5cm depth in substrate
Hydrological Regime: Flow variability	Maintain or restore an appropriate hydrological regime with natural levels of near-bed velocity in mussel habitat
Host Fish	Maintain or restore sufficient juvenile salmonids to host glochidial larvae
Fringing Habitat and condition	Maintain or restore sufficient area and suitable condition of fringing habitats necessary to support the population

QUICK ACCESS 2 - HIERARCHY OF CONSIDERATIONS

Margaritifera is critically endangered, and therefore meaningful, objective-based conservation effort must be employed to ensure the survival of the species. The level and speed of restorations, and the target number of mussels to be restored differs between *Margaritifera* populations – please refer to the Site-Specific Conservation Objectives and individual population guidance for differences, and the NPWS Conservation Strategy (NPWS, 2011). To achieve maximum conservation benefits for resource investment, prioritisation of the implementation of measures is essential. The figure below summarises the *Margaritifera* populations in order of conservation effort priority as identified by Moorkens (2010) and the NPWS (2011).

Group 1 - Priority 1 and 2 of Moorkens (2010). Top 10 priority catchments

These consist of the "Top 8" populations plus two to ensure genetic and regional spread.

These catchments must be restored as soon as technically feasible with full restoration of very large populations in the case of the Top 8 (Bundorragha, Caragh, Cummeragh, Dawros, Glaskeelan, Kerry Blackwater, Owenriff, Ownagappul), and sufficient restoration in the case of the Nore and Derreen.

Group 2 Priority 3-6 of Moorkens (2010). Other peaty catchments in SACs

These consist of peat-dominated catchments that have lower but important numbers of *Margaritifera*.

These populations are: Clady, Eske, Newport, Gearhameen, Allow, Cloon, Owenmore.

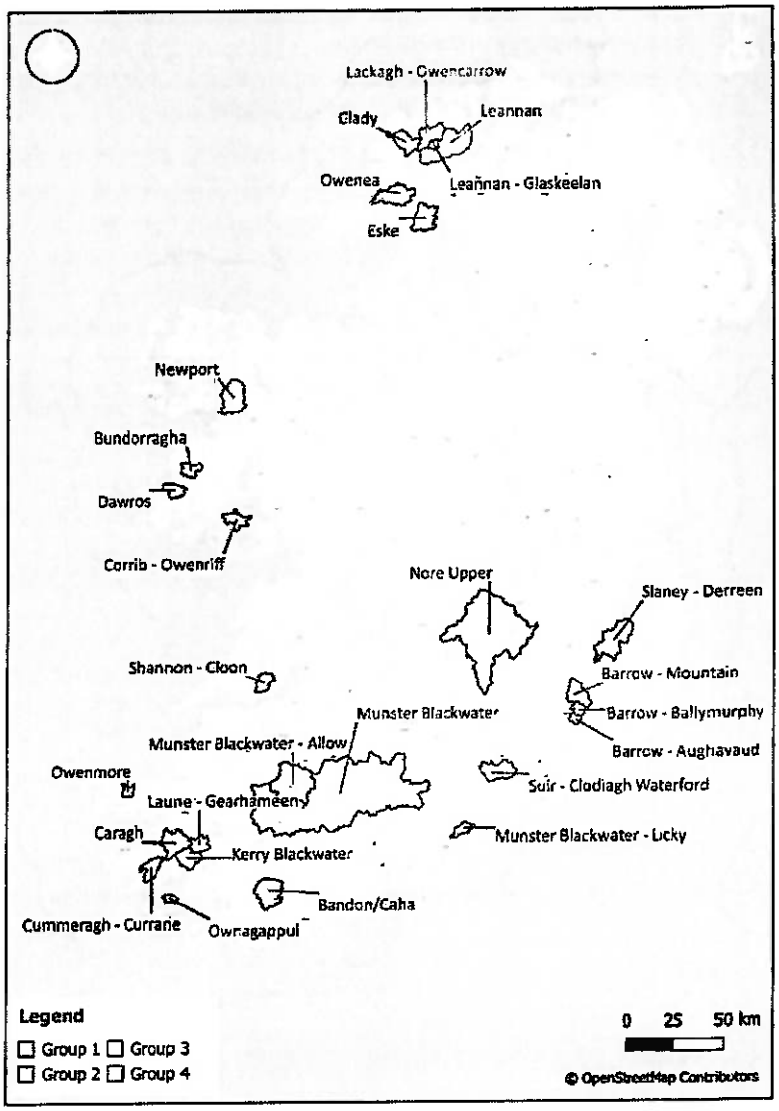
Group 3 Priority 7-8 of Moorkens (2010). Where information was lacking, and now has mostly been resolved, treat as Group 2.

These populations are: Bandon, Owencarrow, Leannan, Owenea.

Group 4 Priority 9 of Moorkens (2010). Much reduced catchments of the south-east with a mixture of upper peaty habitats and lower mineralized, often sandy soils

Care must be taken to restore the more peaty upper catchment areas of these populations, with drier, more mineralized lower stretches being managed and maintained in a safe manner.

These populations are: Munster Blackwater, Licky, Clodiagh, Mountain, Ballymurphy, Aughavaud.



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1 INTRODUCTION TO GUIDANCE FOR *MARGARITIFERA*

1.1 Background and Purpose of Guidance Note

The freshwater pearl mussel, *Margaritifera margaritifera,* is acknowledged to be one of the most demanding species of high water quality and high river bed quality in the world. Due to the extreme sensitivity of *Margaritifera*, all land use activities in a catchment supporting the species must be in keeping with the needs of a thriving mussel population, as just one damaging activity can destroy conservation efforts in the rest of the catchment.

Whilst Ireland supports a significant proportion of the *Margaritifera* populations remaining in Europe, these populations have been in dramatic decline in recent years, with an estimated decline of between 12.6% - 32.7 % between the 2007-2012 and 2013 – 2018 monitoring periods (NPWS, 2019). The species is on the IUCN Red List of Threatened Species and throughout the island of Ireland it is rated as critically endangered.

This Guidance Note relates to the freshwater pearl mussel and its habitat. The guidance is based on legal responsibilities and current best environmental practice relating to *Margaritifera* conservation. It is not a legal interpretation and is not intended to replace existing guidance for other species or habitats but is intended to assist in considering the potential effects of relevant developments, works and activities on *Margaritifera* and its conservation interests.

The Habitats Directive 92/43/EEC (HD) requires Member States to take measures that are designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest. *Margaritifera* is such a species of Community interest, and in order to achieve the conservation objective above, Special Areas of Conservation (SACs) have been established to protect mussels and their habitat. In addition, to achieve favourable conservation status, the natural range of *Margaritifera* must not be reduced so that there will continue to be a sufficiently large habitat to maintain its populations on a long-term basis.

1.1.1 Need for Guidance

Populations of the freshwater pearl mussel can be damaged in a number of ways. Direct damage to the mussel and its habitat can occur in various ways, for example through the removal of river boulders and gravels, or through the construction of bridges, weirs or bank reinforcements within the mussel's habitat.

However, actions in areas outside the immediate habitat of the mussel may also be damaging. This damage may result from a range of activities but occurs in four main ways:

1. Physical river works outside the mussel habitat: Works within the river channel, such as the construction of bridges, weirs or bank reinforcements, may also affect the river morphology downstream and upstream of works, which can immediately or eventually affect mussel habitats.
2. Changes in river flow: Activities such as land drainage, major land-use changes, water abstraction, physical changes to the river and its tributaries by dredging or straightening or by building bridges, weirs or bank reinforcements can all affect the quantity of water in the river, and the speed and direction of river flow.
3. Addition of chemicals and nutrients: A range of substances cause harm to mussels when they enter a river. Industrial pollutants, nutrients (phosphorus and nitrogen which may come from forestry, agriculture, agri-based industries, waste management facilities and sewage inputs), and insecticides (particularly sheep dip) are of serious concern in *Margaritifera* catchments. Drainage works can release toxic iron ochre that can lead to mussel kills.
4. Inputs of sediment: Land drainage, construction works, tillage and animal poaching are among the many activities that can result in the movement of fine sediment from the land to water. Over time this eroded sediment makes its way through ditches and streams into the river and onto pearl mussel populations. Fine sediment can clog up the open gravels and sands that juvenile mussels live in leading to anoxic conditions and mussel death.

5. Biotic factors: Where any of the issues above negatively affect the salmonid host of the *Margaritifera*, damage to mussel populations will also result due to failure of *Margaritifera* larvae to find host fish. Any reduction in numbers and distribution extent (range) of *Margaritifera* results in damage to the resilience of *Margaritifera* through genetic loss.

The approach to management and elimination of risk depends on the nature and scale of the activity itself and on the level of protection that has been afforded to the catchment. However, it must be clearly understood that this guidance is not a prescriptive solution to elimination of risk or prevention of impact on pearl mussels that may result from any development, operation or activity. The very high sensitivity of *Margaritifera* means that every potential aspect of every activity needs to be assessed to ensure that it will not pose a risk to the mussel population or prevent its restoration. In addition, it is essential that all other relevant planning and regulatory requirements are strictly observed.

1.1.2 Scope of the Guidance Note

This guidance note relate to activities, plans and projects specifically within or possibly impacting on *Margaritifera* catchments to ensure that they are undertaken in a sustainable manner and meet with the conservation requirements of the pearl mussel. As such, and given the vulnerability of *Margaritifera*, the guidance represents best practice for operations within such sensitive, high status catchments. The recommendations contained in the guidance note may therefore entail restrictions or requirements that exceed those demanded for operations or developments in other areas.

The guidance note will assist agencies, public authorities and other key stakeholders in relation to proposed activities, plans or projects within, or possibly impacting on *Margaritifera* catchments. The ultimate aim of the guidance note is to ensure sustainable development in pearl mussel catchments by identifying critical risk factors and possible mitigation for specific activities.

They primarily consider field scale issues and works, and are not intended to cover high level, regional planning of a strategic nature. Strategic Environmental Assessment (SEA) is the appropriate process to address the consideration of possible impact of such plans on *Margaritifera* conservation. SEA requires information at a much larger scale than required for assessment and mitigation of project scale activities.

This guidance will support the achievement of the objectives of the Habitats Directive and the Water Framework Directive 2000/60/EC (WFD) in relation to *Margaritifera* conservation. A significant consequence of SI 296/2009 (The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009) is that decision makers must consider waterbodies in *Margaritifera* catchments to have a Water Framework Directive Status of 'High' when consenting to developments involving a direct or indirect discharge to a water body. The guidance also draws on extensive monitoring data collected under both of these legislative provisions. Whilst the application of the guidance will facilitate sustainable practices and responsible stewardship of the land it is important to stress that all planning, legislative and consent requirements must also be complied with. In particular, when operating in SAC catchments where *Margaritifera* is a qualifying interest, Appropriate Assessment and/or damaging activity/notifiable action (ARC) consent is required to ensure that no significant impact on *Margaritifera* conservation status can occur, and that the potential for *Margaritifera* to return to favourable condition in each SAC catchment is not impaired, thereby returning the Irish resource to favourable conservation status.

Note that in the text where reference is made to a *Margaritifera* SAC catchment, this should be taken as reference to river catchments in which a Special Area of Conservation (SAC) has been designated with freshwater pearl mussel as a qualifying interest. A full list of these catchments on the island of Ireland is available below.

1.2 How This Guidance Fits in With Individual Population-Specific Guidance

This guidance is based on a detailed knowledge of the pearl mussel and its needs. Its purpose is to ensure that any activities undertaken in pearl mussel catchments do not pose a risk to *Margaritifera*. The aim is to improve conditions in the catchment so that *Margaritifera* may return to favourable conservation condition.

The guidance can be seen as an overarching document providing detail on the applicability of the guidance, the requirements of *Margaritifera*, information required to undertake an assessment and how an assessment should be undertaken to ensure compliance with the Habitats Directive, Wildlife Acts (1976 – 2023) and Environmental Liability Directive 2004/35/EC.

It is intended that individual population specific guidance will be prepared for all 27 SAC populations nationally and the Blackwater (Munster) River SAC is the first of such population specific guidance documents to be produced. This can be used as a template for other SAC populations that can be developed through the sub basin management plans for the SAC populations.

1.3 *Margaritifera* Distribution and Designations

Populations of the freshwater pearl mussel *Margaritifera margaritifera* are known from North America, northern and central Europe and Russia. The species is declining throughout this entire range and is listed in the most recent IUCN red data assessment as endangered worldwide (Moorkens et al, 2017).

It is important to note that protection is afforded to *Margaritifera* throughout its distribution to ensure that it is maintaining itself on a long-term basis, that its natural range is not being reduced, and that sufficient habitat is available to maintain populations. Therefore, it is necessary to consider the known distribution of *Margaritifera* on the island of Ireland and determine the catchments to which guidance should apply and the level of risk associated with activities. *Margaritifera* distribution has altered radically in recent decades and is likely to continue to do so in the future. As such, an evidence-based approach is proposed to establish the relevance of guidance to any particular catchment.

As a starting point, it is necessary to consider the known distribution of *Margaritifera* on the island of Ireland to determine catchments to which guidance apply. This approach considers the likelihood of impact in a given catchment based on existing knowledge of *Margaritifera* distribution in the catchment. Figure 1.1 shows a map of the distribution of *Margaritifera* in Ireland. The map is based on the *Margaritifera* Sensitive Areas map published by NPWS (2020).

Three categories of *Margaritifera* catchment have been identified:

i. Catchments of SAC populations

ii. Catchments of other extant populations

iii. Catchments with previous records of *Margaritifera* but current status unknown.

Note that since new populations of the freshwater pearl mussel continue to be discovered, this map should not be taken as an exhaustive list of *Margaritifera* catchments. Therefore, when environmental assessment is required in relation to any activity, plan or project it should include an assessment of the possible presence of pearl mussels in water bodies which were previously unsurveyed or where the species has previously been unrecorded. This is particularly important in areas where suitable bedrock could provide favourable river habitat to support freshwater pearl mussels, or where records occur for nearby rivers.

Further explanation of these three categories and the relevance of the guidance notes, including implications in relation to environmental assessment of potentially damaging activities, plans or projects is provided below:

1. Catchments of SAC populations. These *Margaritifera* populations occur within SACs that have been designated specifically for the protection of the species.

Site-specific conservation objectives for the restoration of SAC populations and their habitats in Ireland are being developed by the NPWS (see http://www.npws.ie/protectedsites/). Under S.I. 296 of 2009, 27 draft Sub-basin Management Plans have been developed to provide the programmes of measures necessary to achieve these objectives.

The *Margaritifera* guidance notes apply to all relevant sectoral activities in these catchments, and any proposed plans or projects that occur wholly, or partially within the catchment of a designated *Margaritifera* SAC, or which may affect the *Margaritifera* SAC, must be screened for Appropriate Assessment (Article 6 (3), Habitats Directive). Detailed information on the distribution and abundance of freshwater pearl mussels is already available in many of these catchments, and can be accessed through the regulatory agencies to assist in this process (see: http://www.npws.ie/mapsanddata/requestdata).

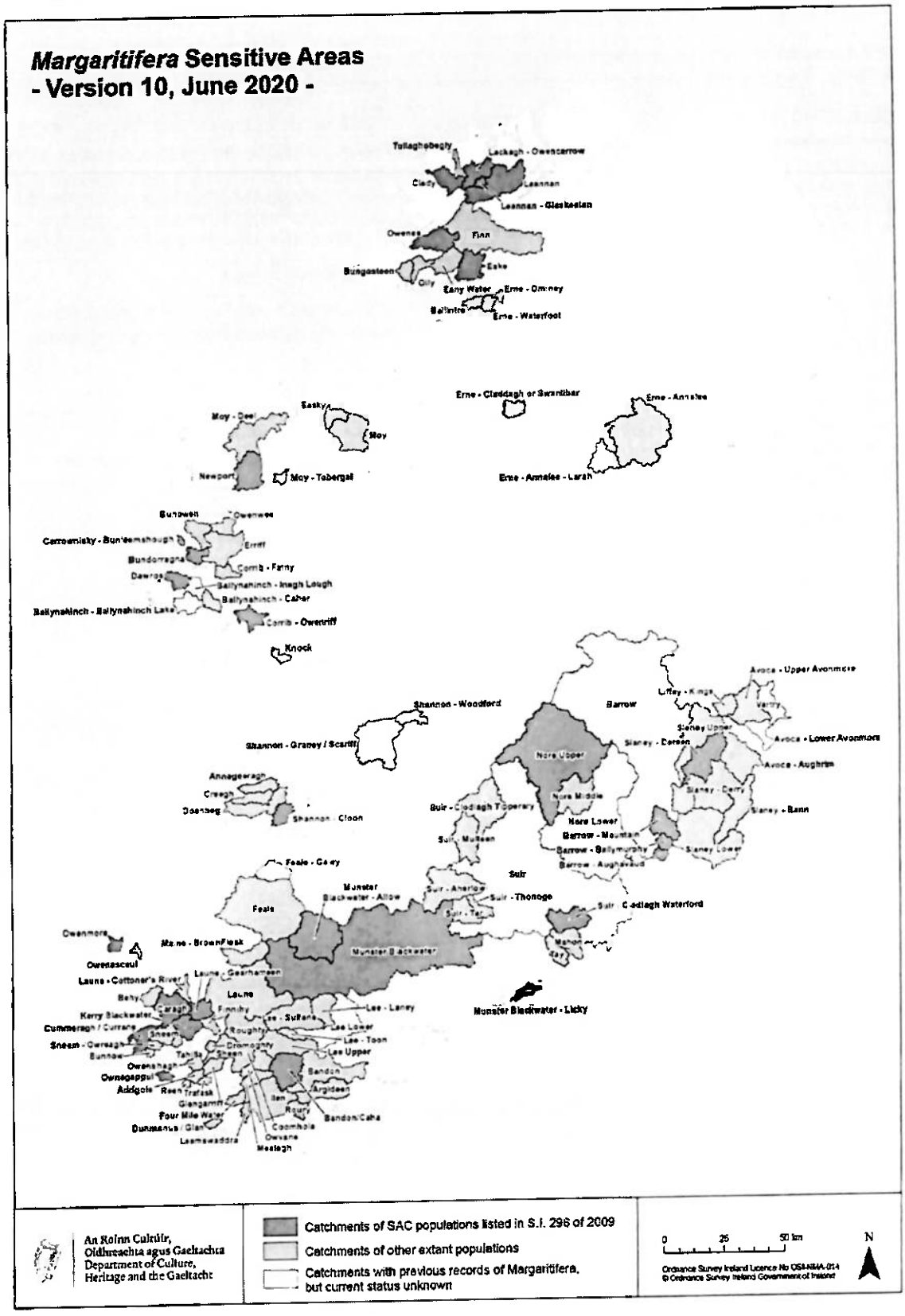


Figure 1.1 *Margaritifera* Sensitive Areas In Ireland

2. Catchments of other extant populations.

Some of the extant mussel populations shown in Figure 1.1 may occur within (or partly within) an SAC, but *Margaritifera* does not comprise part of the qualifying interests of those SACs. Extant populations also occur in sites with other nature conservation designations, or in sites with no designation. Regardless of where these populations occur, and although no detailed *Margaritifera* conservation plans are available for such sites, the *Margaritifera* guidance applies to all relevant sectoral activities in these catchments. In addition, the potential effects of any plans, developments or activities on the populations, including the potential to cause 'environmental damage' as per the Environmental Liability Directive and transposing regulations in Ireland, must be determined through SEA, EIA or other environmental assessment. The NPWS hold some detailed information on the distribution and abundance of freshwater pearl mussels in a number of these catchments.

3. Catchments with previous records of *Margaritifera* but current status unknown

While there are no recent records of freshwater pearl mussel from these catchments, in most cases there has been little, if any, survey for the species since 1970. The agencies hold very little information on these populations.

If any plans, or potentially damaging developments and activities are proposed for these catchments, freshwater pearl mussel should be considered as a constraint and initially consultation should be undertaken with the relevant authorities. A dedicated survey to establish presence or absence of the species is recommended. In the event that *Margaritifera* is confirmed as present in the catchment, then it should be treated as per the other catchments of extant populations at 2 above.

1.4 *Margaritifera* Requirements

In order to prepare guidance, a clear scientific understanding of the ecological requirements for a fully functioning *Margaritifera* population is needed. Under the EU Habitat's Directive, a key objective is to maintain or restore species that are protected under Annex II (including *Margaritifera*) at favourable conservation status. This is defined under the Directive as:

- Population dynamics data on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitat;
- The natural range of the species is not being reduced;
- There will be sufficiently large habitat to maintain its populations.

The EU Member States must therefore understand the ecological status of their *Margaritifera* populations both in terms of demography of the population itself, the physico-chemical condition of the mussel habitat, the surface waters that are supporting it, and the conditions needed within the catchments of *Margaritifera* populations that can sustain these ecological requirements.

The habitat of *Margaritifera* in Ireland does not match well with any particular Habitat's Directive Annex I or CORINE habitat. It is restricted to near pristine, clean flowing waters, often downstream of ultra-oligotrophic lakes.

Maintaining natural flow variability in *Margaritifera* catchments is an essential requirement for a fully functioning population, including enough high flows to cleanse river-bed substrates. The most appropriate way of ensuring adequate flow in *Margaritifera* populations is to maintain a natural, abstraction-free regime in the sub-catchment influencing the population, and to manage the surrounding catchment in a manner that does not affect the natural flow regime (e.g. by avoiding artificial drainage, coniferous afforestation, other afforestation requiring drainage, on peat soils >10cm depth, and/or at density levels that result in interception and evapotranspiration levels that lead to decreased soil moisture, wetland removal, installation of weirs and dams). Adult pearl mussels require enough water to cover them and a velocity at bed level that permits adequate filter feeding, while the substrate needs sufficient oxygen supply in the areas where juveniles are living. The area occupied by mussels should not be reduced by loss of adult or juvenile habitat through inadequate flows.

Margaritifera requires stable cobble and gravel substrate with very little fine material below pea-sized gravel. Adult mussels are partially buried (approximately two thirds of their length) and juveniles up to 5-10 years old are totally buried within the substrate. The lack of fine material in the riverbed substrate allows for free water exchange between the open river and the substrate's interstitial water. This ensures that oxygen levels within the substrate do not fall below those of the open water. The substrate must be free of inorganic silt, organic peat and detritus, as all of these can block oxygen exchange. Organic particles within the substrate further exacerbate the problem by consuming oxygen during the process of decomposition. Clean, coarse and stable substrate is essential for juvenile survival, as this species requires continuously high oxygen levels.

The habitat must be almost totally free of filamentous algal growth and rooted macrophyte growth. Both block free exchange between the water column and the substrate and may also cause night time drops in dissolved oxygen at the water-sediment interface. In order to limit algal and macrophyte growth, the open water must be of high quality with very low nutrient concentrations. Nutrient levels must be close to reference levels for ultra-oligotrophic rivers, and phosphorus must never reach values that result in filamentous algal growth.

Siltation of the river substrate associated with chronic erosional losses of fine sediments also provides a rooting medium for higher plants. Nutrients accumulated in the sediment may be chronically or intermittently available in the open water, and further promote the growth of algae and macrophytes. This exacerbates the stressful environment for the adult and juvenile mussels, and as more adults are lost, further niches for macrophyte growth become available. There is a resultant trophic cascade in the habitat, with succession from oligotrophic to eutrophic conditions and a resultant change in the invertebrate species composition.

It must also be noted that there must be sufficient salmonid host fish present to carry the larval glochidial stage of the pearl mussel life cycle if it is to reach favourable conservation status. While the conditions described above are likely to also result in suitable habitat for salmonids, barriers to migration may exclude salmonids from previously occupied river stretches. *Margaritifera* populations may exhibit preferences or specificity in relation to host salmonid species or genotypes, and this must also be considered in any

assessment of available salmonid hosts. NPWS has undertaken fish host and genetic studies that may be helpful in assessments (Johnston & Moorkens, 2018; Geist et al., 2018).

1.5 Causes of Decline

Margaritifera is extremely sensitive to changes in its environment, and the species is subject to a wide range of pressures which can act alone or in-combination with other pressures to negatively affect populations (NPWS, 2019). In general, any activities or projects within the catchment which result in changes to the processes or functioning of the river system (e.g., changes in the hydrological regime or modification of hydrological conditions, pollution with fine sediment and nutrients) are likely to have a negative effect on *Margaritifera* populations. *Margaritifera* is particularly sensitive to habitat deterioration arising from changes in water quality and hydromorphology (the flow and physical character of the river) (Moorkens, 2020).

There are a number of ways in which changes to the processes and functioning of river systems can affect *Margaritifera* populations. For example, most recruitment issues can be linked to sedimentation of the interstitial spaces within the riverbed, which can physically impede filter-feeding and oxygenation (Moorkens & Killeen, 2014). This issue can be made worse by elevated nutrients within the river, which can result in eutrophication and an increase in organic sedimentation via decomposition (Moorkens & Killeen, 2014). Juvenile mussels, which live buried within the river sediment and filter interstitial water, cannot be recruited in these conditions, and in rivers with chronic sedimentation, juvenile recruitment is rare and unsustainable (National Standards Authority of Ireland (NSAI), 2017). Older mussels can survive in these conditions as they filter open water. However, as the older mussels die, there will be no younger mussels to replace them within the population. These populations will ultimately become extinct if conditions which support juvenile mussels are not restored. The status of these populations is described as 'functionally extinct' (NSAI, 2017).

Pollution events can lead to mortality of juveniles, or the mortality and/or displacement of adults. Such pollution events can be chronic or acute. Juvenile mussels live in the river substratum for a period of at least five years and therefore long-term maintenance of suitable habitat conditions for juveniles is essential. Temporary declines in condition can lead to the mortality of all juveniles produced in the previous five years[1]. *Margaritifera* habitat loss and deterioration is also a significant issue as while negatively affecting existing populations, the deterioration of habitat can also prevent or at least reduce the likelihood of the establishment of new populations elsewhere, thereby reducing the resilience of *Margaritifera* within the catchment. Furthermore, given the reliance of *Margaritifera* populations on salmonid host fish to complete their lifecycle, loss of salmonid hosts from the river system (e.g., due to barriers to migration, habitat loss, acidification or pollution, competition from non-native fish species, for example) will negatively affect *Margaritifera* populations.

Figure 1.2 below shows a schematic describing the various catchment level activities and pressures affecting *Margaritifera*, the impact of these activities on processes within the river system, the effects of the changes in river processes on *Margaritifera* populations and habitat requirements, and the eventual outcome for *Margaritifera* populations.

[1] NPWS (n.d.) Causes of Decline. https://www.npws.ie/research-projects/animal-species/invertebrates/freshwater-pearl-mussel/causes-decline (accessed 14th July 2023).

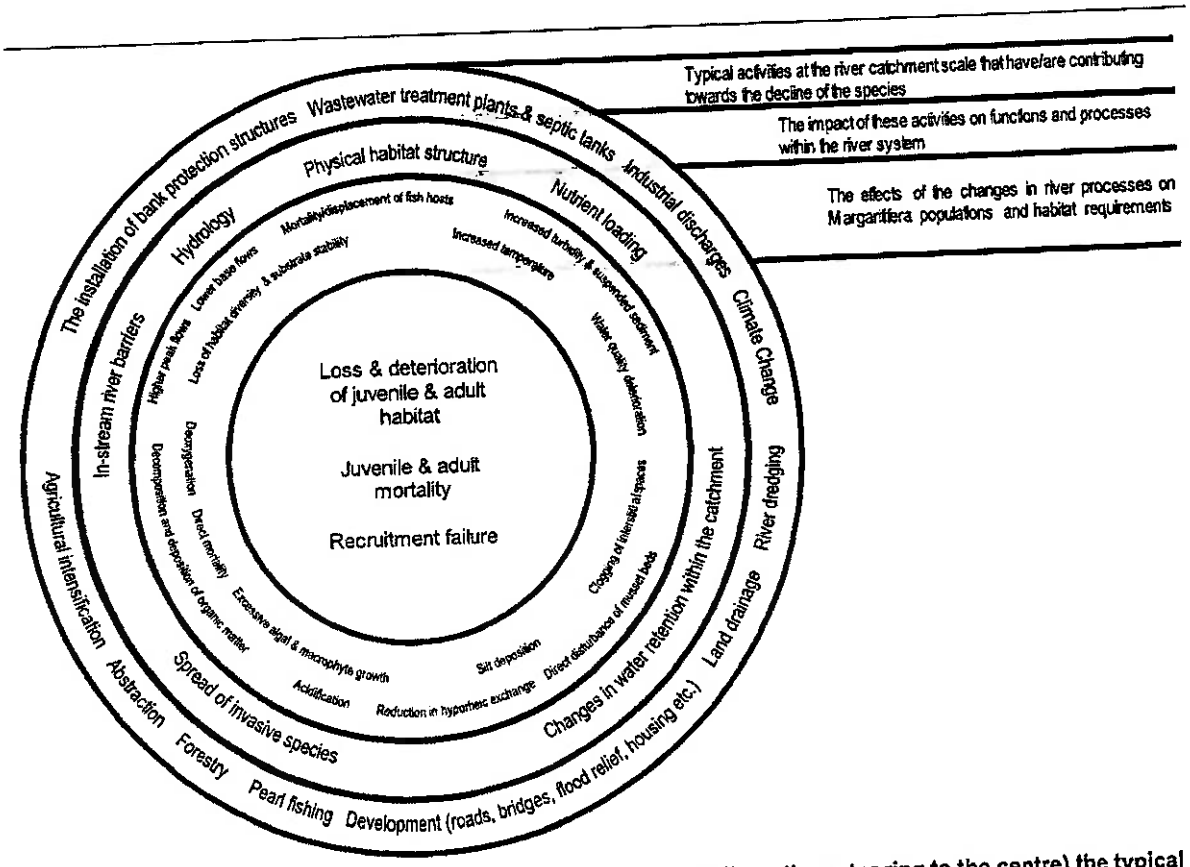


Figure 1.2. Causes of *Margaritifera* decline. The schematic shows (from the outer ring to the centre) the typical activities at the river catchment scale that have/are contributing towards the decline of the species, the impact of these activities on processes within the river system, the effects of the changes in river processes on *Margaritifera* populations and habitat requirements, and the eventual outcome for *Margaritifera* populations. Based on various sources namely NASI (2017), NPWS (2019), Moorkens & Killeen (2014).

1.6 Protection Under Irish and EU Legislation

The threatened nature and widespread decline of *Margaritifera* populations has led to its legal protection under national and international legislation. The Wildlife Acts (1976-2023) are the most important national legislation providing for the protection of wildlife in Ireland. *Margaritifera* is afforded legal protection under the Wildlife Acts in Ireland and was given protected faunal species status in 1990 (S.I. No. 112 of 1990). Furthermore, environmental objectives for the species have been established in law (the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations, S.I. 296 of 2009). The 2009 regulations set environmental quality objectives for the habitats of the listed freshwater pearl mussel SAC populations, and require the preparation of Sub-basin Management Plans, with programmes of measures to achieve the objectives within the plans.

At a European level, *Margaritifera* is protected under the Habitats Directive[2] and is listed under Annex II and Annex V of the Directive. Annex II lists animal and plant species of Community interest whose conservation requires the designation of SACs. Special Areas of Conservation, designated under the Habitats Directive, together with Special Protection Areas (SPAs) designated under the Birds Directive (79/409/EEC) comprise the Natura 2000 network. Implementation of the Habitats Directive in Ireland has led to the designation of 19 SACs for the protection of *Margaritifera* (Table 1.1). Annex V lists species for which Member States must take measures to ensure that the taking or exploitation of specimens of the species (e.g., pearl fishing) is compatible with their being maintained at a favourable conservation status. In Ireland, all pearl fishing and other disturbance of *Margaritifera* has been banned since 1990 (S.I. No. 112 of 1990).

[2] Transposed into Irish law via the European Communities Birds and Natural Habitats Regulations 2011 (S. I. No. 477 of 2011).

As well as the direct transposition of the Habitat's Directive into the 2011 regulations[2], the Habitat's Directive has been transposed into a range of other Irish regulations, such as planning, agriculture and other regulations that require compliance with the Habitat's Directive.

The EU Water Framework Directive is the most important piece of water legislation in Europe. The Directive requires all Member States to protect and improve water quality in all waters so that "good ecological status" is achieved by 2027. However, waterbodies in *Margaritifera* catchments require a Water Framework Directive Status of 'High' (SI 296/2009). It was transposed into Irish law by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003). The Directive applies to all waterbodies - rivers, lakes, groundwater, transitional and coastal waters. The WFD requires that Members States manage their waters on the basis of River Basin Districts (RBDs), and that River Basin Management Plans (RBMP) are prepared for each RBD. The RBMP must contain a programme of measures which outlines how the Directive's environmental objectives will be achieved in each RBD. In Ireland, the river basin management planning process is based on a single national River Basin District covering an area of 70,273 km^2. It is broken down into 46 catchment management units (see Catchments.ie).

There is overlap between EU nature directives (Birds Directive and Habitats Directive) and the WFD. Under Article 6 of the WFD, Member States are required to "*ensure the establishment of a register or registers of all areas lying within each river basin district which have been designated as requiring special protection under specific Community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly depending on water.*" The register must include all bodies of water identified under Article 7(1) of the Directive and all protected areas covered by Annex IV, and must be kept under review and up to date. As such, any Natura 2000 site with water-dependent habitats or species (listed on Annex I and II of the Habitats Directive or water-dependent bird species of Annex I or migratory bird species of the Birds Directive), and, where that protected area has been designated due to the presence of those species or habitats, has to be considered for the register of protected areas under WFD Article 6 (European Commission, 2011). These areas are referred to as "water-dependent Natura 2000 sites" and for these Natura 2000 sites, the objectives of the Birds Directive, Habitats Directive and WFD apply (European Commission, 2011). Protected areas that have been designated only for national purposes (i.e., those areas outside of the Natura 2000 network) can also be included in the register (European Commission, 2011). In Ireland, approximately 88% or 385 of the 439 SACs have water dependent habitats or species, whereas 90% or 149 of the 165 SPAs have water dependent bird species (Catchments.ie).

With regard to protected areas, Article 4 1. (c) of the WFD states that the programmes of measures specified within the RBMP "*shall achieve compliance with any standards and objectives at the latest 15 years after the date of entry into force of this Directive, unless otherwise specified in the Community legislation under which the individual protected areas have been established.*" Under Article 11 of the WFD, the Birds and Habitats Directive are "basic measures" that need to be included and implemented within the programme of measures. As such, the programme of measures must include any measures necessary to achieve compliance with the standards and objectives for Natura 2000 sites listed in the register of protected areas (i.e., achievement of favourable conservation status of species and habitats in water-dependent SACs and SPAs) (European Commission, 2011).

Table 1.1.The SACs where *Margaritifera* is listed as a qualifying interest[3].

Site Code	Special Area of Conservation
000140	Fawnboy Bog/Lough Nacung SAC
000163	Lough Eske and Ardnamona Wood SAC
000197	West of Ardara/Maas Road SAC
000297	Lough Corrib SAC
000365	Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment SAC
000375	Mount Brandon SAC
000781	Slaney River Valley SAC
001879	Glanmore Bog SAC
001932	Mweelrea/Sheeffry/Erriff Complex SAC
002031	The Twelve Bens/Garraun Complex SAC
002047	Cloghernagore Bog and Glenveagh National Park SAC
002137	Lower River Suir SAC
002144	Newport River SAC
002162	River Barrow and River Nore SAC
002165	Lower River Shannon SAC
002170	Blackwater River (Cork/Waterford) SAC
002171	Bandon River SAC
002173	Blackwater River (Kerry) SAC
002176	Leannan River SAC

[3] https://www.npws.ie/research-projects/animal-species/invertebrates/freshwater-pearl-mussel/irish-sacs

2 LEGLISATION FOR THE PROTECTION OF *MARGARITIFERA*

2.1 The Wildlife Act Protection For Non-Designated Populations

Margaritifera is afforded legal protection under the Wildlife Acts (1976 - 2023) in Ireland. The species was added to the fifth schedule of the Act under Statutory Instrument No. 112 of 1990. Therefore, under section 23, it is an offence to injure or wilfully interfere with or destroy the breeding place or resting place of *Margaritifera*. Surveys of *Margaritifera* within a watercourse carry an inherent risk of damage to mussel beds and mussel habitats, and therefore a licence is required under sections 9, 23 and 34 of the Wildlife Act to undertake surveys of the species. This applies even where visual inspections (Stage 1 and Stage 2 surveys (Anon., 2004)) are proposed. The Wildlife Act affords protection to all *Margaritifera* populations within Ireland, regardless of whether they occur within or outside of an SAC. All removal of mussels, such as for pearl fishing, is banned.

2.2 Protection of the "Irish Resource" under the Habitat's Directive and Environmental Liability Directive. Requirements of the CEN Standard.

2.2.1 Habitats Directive

The Habitats Directive provides legal protection for habitats and species of European importance. The main aim of the Habitats Directive is "*to contribute towards ensuring biodiversity through the conservation of natural habitats of wild fauna and flora in the European territory of the Member States to which the treaty applies*" (92/43/EEC). A key aim of the Habitats Directive is to achieve "*favourable conservation status*" of species and habitats. Conservation status of a species, according to the directive, "*means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2*". Favourable conservation status for a species is defined in the directive (Article 1) as follows:

- *"population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
- *the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
- *there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."*

As noted previously, *Margaritifera* is protected under the Habitats Directive and is listed under Annex II and Annex V. Special Areas of Conservation must be designated under the Habitats Directive to protect habitats listed under Annex I and species listed under Annex II, and measures taken pursuant to the Directive must be designed to maintain or restore these habitats and species 'at favourable conservation status.'.

Under Article 6(1) of the Habitats Directive, Member States are required to establish the necessary conservation measures to maintain or restore the habitats and species for which the site has been designated to a favourable conservation status. Under Article 6(2) of the Habitats Directive, Member States are required to avoid damaging activities that could result in significant disturbance of listed species and their habitats and deterioration of listed habitats.

Article 6(3) and (4) set out a series of procedural and substantive safeguards governing plans and projects likely to have a significant effect on a designated site.

2.2.2 Environmental Liability Directive

The Environmental Liability Directive 2004/35/EC establishes a framework of environmental liability based on the "polluter pays" principle making operators of an occupational activity liable for the prevention and remediation of environmental damage. Where environmental damage has occurred, the operator must cover the costs of the remediation measures and any costs incurred by the competent authority. The

Environmental Protection Agency (EPA) is the designated competent authority within Ireland for the enforcement of the regulations.

The Directive has been partially transposed into Irish law through the European Communities (Environmental Liability) Regulations (2008) and the Environmental Liability Act (tbc) (EPA, 2011). The principal aims of the Regulations are to prevent and remediate water damage, land damage and damage to natural habitats and protected species. Under the Directive, "protected species and natural habitats" is defined as:

- the species mentioned in Article 4(2) of the Birds Directive or listed in Annex I thereto or listed in Annexes II and IV of the Habitats Directive;
- the habitats of species mentioned in Article 4(2) of the Birds Directive or listed in Annex I thereto, the habitats of species listed in Annex II of the Habitats Directive, the natural habitats listed in Annex I and the breeding sites or resting places of the species listed in Annex IV of the Habitats Directive; and
- any habitat or species, not listed in those Annexes which the Member State designates for equivalent purposes as those laid down in the Habitats and Birds Directives.

Damage to protected species and natural habitats is defined as "*any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species*". The significance of such effects must be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I of the Directive.

As *Margaritifera* is listed under Annex II of the Habitats Directive, it is a "protected species" as defined under Article (2) of the Environmental Liability Directive and is therefore afforded protection under this legislation.

2.2.3 CEN Standard

I.S. EN 16859:2017 is the adopted Irish version of the European Document EN 16859:2017, Water quality - Guidance standard on monitoring freshwater pearl mussel (*Margaritifera margaritifera*) populations and their environment. The European Standard was approved by the European Committee for Standardization (CEN) in December 2016. This standard, published in 2017, provides guidance on monitoring populations of freshwater pearl mussel as well as their habitat to aid in the conservation of the species, and sets out a series of requirements for achieving favourable condition for *Margaritifera* populations. The standard was developed through a series of workshops attended by specialists in pearl mussel biology with at least 40 specialists representing 10 countries taking part in at least one workshop (Boon et al., 2018).

The standard provides a number of checklists which outline the parameters that should be monitored in rivers with a *Margaritifera* population including the monitoring of mussel attributes, fish hosts, water quality, biotic indicators and hydromorphology. As noted by Boon et al. (2018) the standard does not outline threshold values for different water quality parameters, rather, the standard uses data from studies across Europe to list levels of various substances. This is because aquatic ecosystems are often affected by multiple stressors simultaneously (e.g., siltation, hydromorphological degradation, nutrient enrichment), and the impact of these stressors will often result in synergistic effects (i.e., the interaction of various parameters results in an overall effect that is greater than the sum of the individual parts) on *Margaritifera*, as opposed to singular effects (Boon et al., 2018). Furthermore, tolerance to various water quality stressors can vary between *Margaritifera* populations, potentially arising from local adaptation. Therefore, the delineation of single threshold values is considered inappropriate (Boon et al., 2018).

The standard also provides a checklist of environmental pressures that should be considered in risk-based monitoring, as well as a checklist of questions that should be addressed to ensure that short-term activities or long-term plans or projects do not damage *Margaritifera* populations. The latter checklist (table 8 of the standard) is of particular relevance to this guidance document. The questions address various aspects that need to be considered during the assessment stage of a proposed development, and include the mussel population, fish hosts, non-native species, water quality, flow, substrate quality, riparian land use and vibration and drilling/blasting/noise. The questions provide a useful tool for developers, environmental consultants and planning authorities to aid in the identification of the various elements of a proposed development that need to be considered in order to adequately assess the potential effects of a proposed development on a *Margaritifera* population. An example of the questions asked is shown in Table 2.1.

However, as noted by Boon et al. 2018, there is considerable variation in the nature of proposed plans and projects as well as the sensitivity of their locations. As such, a "one size fits all" approach to assessment is not appropriate, and it is important that assessments are tailored to the needs of individual cases (Boon et al., 2018).

Table 2.1. Sample questions extracted from table 8 of I.S. EN 16859:2017 - Checklist of questions that should be addressed to ensure that plans or projects do not damage *Margaritifera* populations.

Aspect	Question
Mussel population	Will the plan or project increase the risk of pearl fishing, or direct disturbance to mussel beds?
Fish hosts	Has the plan or project the potential to affect the upstream or downstream migration of salmonids, including the timing of their movements?
Water quality	Will there be a new outfall or changes to an established outfall entering the river?
	Will changes to land management have the potential to increase nutrient loading to the river?
Flow	Is there any modification to drainage, or dewatering associated with the plan or project?
	Has the plan or project the potential to affect the flow regime in the river in any other way?

The standard also includes 3 'informative' annexes[4], which cover background information on the environmental characteristics important for maintaining populations of *Margaritifera* (Annex A), targets for assessing whether *Margaritifera* populations are in favourable condition (Annex B) and the range of environmental conditions supporting sustainable populations of *Margaritifera* (Annex C).

It should be noted that the standard acknowledges the importance of taking into consideration the unique pressures on each individual population when setting priorities for monitoring. The standard also recognizes that it may not be necessary to monitor all of the various aspects for every investigation. Rather, the purpose of the monitoring should determine which aspects need to be considered.

2.3 Protection Of Populations Designated Under the Habitat's Directive

2.3.1 European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations

Under Article 6 of the Habitats Directive Member States must show the steps taken to achieve the Directives objectives as well as avoiding deterioration in those natural habitats and habitats of Annex II species. To assist in the achievement these requirements in Ireland, the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (S.I. No. 296) have been established.

The Regulations require the development and implementation of 27 Freshwater Pearl Mussel Sub Basin Management Plans (SBMP), one for each of the 27 populations in the 19 SACs listed in the regulations and the achievement of favourable conservation status for the pearl mussel in the Republic of Ireland. The publication, implementation and revision of sub-basin Management Plans has not been undertaken as required by the legislation to date (2023). First round drafts are available but are outdated and as such are likely to be misleading.

The Regulations:

a. Set environmental quality objectives for the habitats of the freshwater pearl mussel populations named in the First Schedule to these Regulations that are within the boundaries of a site notified in a candidate list of European sites, or designated as a Special Area of Conservation, under the European Communities (Natural Habitats) Regulations, 1997 (S.I. No. 94/1997).

b. Require the production of sub-basin management plans with programmes of measures to achieve these objectives.

[4] An informative annex is for information only and is not considered to be an integral part of the standard itself.

c. Set out the duties of public authorities in respect of the sub-basin management plans and programmes of measures.

Regulation 6 details the work necessary for the preparation of the SBMPs, specifically:

a. Baseline monitoring of those ecological elements identified in the Third and Fourth Schedule to these Regulations,

b. Investigative monitoring to, where necessary, identify the pressures and their sources, which have led to unfavourable conservation status of the freshwater pearl mussel.

Regulation 7 determines that the Minster shall hold public consultation on the draft SBMPs.

Regulation 8 details that the SBMPs shall:

a. Specify objectives and targets, in accordance with Regulation 2, and the Third and Fourth Schedules to these Regulations, and deadlines for their achievement;

b. Provide for the investigation of sources of pressures leading to the unfavourable conservation status of the freshwater pearl mussel;

c. Establish a programme of measures, including a timeframe, for the reduction of pressures giving rise to unfavourable conservation status. The programme shall include pressure reduction targets and deadlines, either in relation to individual pollutants or to particular sectors or activities or both, to be implemented within the sub-basin, or parts of the sub-basin as appropriate;

d. Lay down a detailed programme of monitoring to be implemented within the sub-basin, or parts of the sub-basin as appropriate, in order to evaluate the effectiveness of measures and progress made towards restoring favourable conservation status.

A significant consequence of this legislation is that decision makers must consider waterbodies in the *Margaritifera* catchments to have a Water Framework Directive Status of 'High' when consenting to developments involving a discharge to a water body.

Responsible Authorities

The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 set out the duties of public authorities in respect of the SBMPs:

It shall be the duty of a public authority listed in the Second Schedule to these Regulations to take such steps as are necessary and appropriate to the discharge of its functions to implement the measures identified in a sub-basin management plan.

Under the Regulations, the Minister for the Environment, Heritage and Local Government is responsible for overseeing the implementation of the SBMPs. Regulation 14 states:

"The Minister shall monitor the implementation by public authorities of the sub-basin management plans and measures referred to in Regulation 8, and shall take such steps as necessary to ensure their implementation."

2.3.2 The individual Conservation Objectives for each population

Under the European Communities (Natural Habitats) regulations S.I. 94 of 1997 as amended the definition of "conservation objectives", in relation to a European Site, means *"the maintenance and restoration of the habitat and species in respect of which the site has been identified as a European Site at favourable conservation status or their restoration to such favourable status, and shall include such particular objectives as the Minister may from time to time establish for those purposes under Regulation 26."*

Therefore, the conservation objectives ("COs") for each European site are to maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the site has been selected.

The favourable conservation status (or condition, at a site level) of a species is achieved when the criteria under 2.2.1 above are satisfied.

The conservation objectives for *Margaritifera* are largely the same across all SAC populations and are to restore the favourable conservation condition of Freshwater Pearl Mussel in each SAC, which is defined by a list of attributes and targets based on distribution, population demographics, habitat condition, ecological requirements, host species and fringing habitats. Very few SAC populations have been in Favourable

condition since Article 17 reporting began (2007). The conservation objective for all SAC populations is to restore favourable condition, thereby contributing to 'favourable conservation status'. See "quick access 1" above (page ii).

2.3.3 The importance of condition – maintain or restore

The importance of the condition of the different attributes of favourable conservation status is central to the development of the guidance note, particularly as to whether the conservation objectives for an SAC population is to maintain or restore favourable condition for each attribute contributing to the conservation status for *Margaritifera*.

As outlined above, the conservation objectives for each individual *Margaritifera* SAC population have been developed and provide the attributes and targets to be achieved when assessing whether *Margaritifera* populations are in favourable condition. The CEN Standard also provides background information on the environmental characteristics important for maintaining populations of *Margaritifera* (Annex A), targets for assessing whether *Margaritifera* populations are in favourable condition (Annex B) and the range of environmental conditions supporting sustainable populations of *Margaritifera* (Annex C).

This information is necessary to establish whether the maintain or restore function is necessary for the conservation status of each individual *Margaritifera* population and also the resilience of the national population (considering factors such as number of sites occupied, geographical distribution, pressures, etc.) in reporting the conservation status and setting targets to ensure the long-term survival of a species within a member state.

2.3.4 Activities Requiring Consent (ARCs)

Article 6(2) of the Habitats Directive makes provision for avoidance of habitat deterioration and significant species disturbance. Its emphasis is therefore preventive. It has a larger scope than Articles 6(3) and 6(4) which are limited to plans or projects that require authorizations. Article 6(2) applies to activities which do not necessarily require development control authorisation or other licensing regime, e.g., certain agriculture activities. This article of the Directive requires Member states to take all reasonable measures to ensure that no deterioration of habitat or disturbance of species occurs.

Activities requiring consent (ARCs) are specific activities which have the potential to damage a European Site. The NPWS established a list of 38 ARCs, ranging from "Reclamation, including infilling" to "Works on, or alterations to, the banks, bed or flow of a drain, watercourse or waterbody." The particular ARC or ARCs attached to a European Site depends on the habitats and/or species for which the site is protected.

ARCs are not prohibited activities but in advance of being undertaken, consent must be granted by the Minister for Housing, Local Government and Heritage ('the Minister') under Regulation 30 of the Habitat Regulations or by another relevant public authority to which the consent function for that activity falls. This requirement ensures that the Minister (or the relevant competent authority) carries out the necessary environmental assessment to determine if the activity can take place and if any conditions should be attached to any consent given. It is an offence to carry out an ARC without prior consent.

2.3.5 Overlapping legal restrictions from other legislation (e.g., GAP, the sub-basin plans)

There are other restrictions imposed by other legislation that can contribute to the overall protection of the individual populations designated under the Habitats Directive and transposing legislation. Some of the key legislative restrictions are outlined below.

Strategic Environmental Assessment

Environmental assessment at plan or policy level is termed Strategic Environmental Assessment (SEA), whereas environmental assessment at project level is termed Environmental Impact Assessment (EIA). Both processes are targeted at Projects and Plans that are likely to have significant effects on the environment. SEA is defined as a strategic framework instrument that helps to create a development context towards sustainability by integrating environment and sustainability issues in decision-making, assessing strategic development options and issuing guidelines to assist implementation.

The purpose of SEA is to ensure that the environmental consequences of a plan, policy or programme of a strategic nature are assessed both during preparation and prior to adoption. SEA acts strategically in relation to the decision-making process by ensuring strong interaction and frequent iteration throughout the decision cycles. It integrates relevant biophysical, social, institutional and economic issues, keeping a strategic focus in critical themes. SEA assesses the environmental and sustainability opportunities and the risks of strategic options so that development is driven into sustainability pathways.

Environmental Impact Assessment

Environmental assessment at project level (e.g., a motorway, housing development) is termed Environmental Impact Assessment (EIA). Environmental Impact Assessment has been in operation in Ireland for over 20 years and is regarded as a mature and standard process. The objective of EIA is to provide decision makers with relevant environmental information before formal decisions are made on implementation of the project.

The general principles of EIA, as practiced in Ireland and in other Member States, is that it must be preventative, scientific, transparent and participative, and it must deal with broad environmental concerns.

Environmental Impact Assessment is a method of ensuring that the likely effects of new development on the environment are fully understood and taken into account before consent is given for the development to proceed. As such its purpose is to improve the quality of decision making by identifying potential environmental issues early in the project process.

An Environmental Impact Assessment Report (EIAR) is the document produced by the developer to inform the EIA process conducted by the decision maker. It consists of a systematic analysis of the proposed development in relation to the existing environment.

Ecological Impact Assessment

Ecological Impact Assessment (EcIA) is a process of identifying, quantifying and evaluating the potential effects of development-related or other proposed actions on habitats, species and ecosystems (CIEEM, 2018). The purpose of EcIA is to provide the competent authority with information about the likely significant ecological effects associated with a project and the information required to determine whether a project is compliant with relevant nature conservation policy and legislation. Where mitigation is required, the EcIA should allow the competent authority to write conditions / obligations that ensure mitigation is implemented.

Water Framework Directive

The WFD is the most important piece of water legislation in Europe. The Directive requires all Member States to protect and improve water quality in all waters so that at least "good ecological status" ("high" in *Margaritifera* waters) is achieved by 2027. The WFD requires that Members States manage their waters on the basis of River Basin Districts (RBDs), and that River Basin Management Plans (RBMP) are prepared for each RBD. The RBMP must contain a programme of measures which outlines how the Directive's environmental objectives will be achieved in each RBD.

Under Article 6 of the WFD, Member States are required to "*ensure the establishment of a register or registers of all areas lying within each river basin district which have been designated as requiring special protection under specific Community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly depending on water.*" As such, any European Site with water-dependent habitats or species and where that protected area has been designated due to the presence of those species or habitats, has to be considered for the register of protected areas under WFD Article 6 (European Commission, 2011). These areas are referred to as "water-dependent Natura 2000 sites" and for these Natura 2000 sites, the objectives of the Birds Directive, Habitats Directive and WFD apply (European Commission, 2011). See section 1.6 for more detail.

The European Communities (Water Policy) Regulations as amended is the national legislation transposing the Water Framework Directive into Irish Law. The Regulations are the key legislative instrument for the implementation of the objectives of the WFD. Regulation 13 specifies that a river basin management plans may be supplemented by the production of additional detailed programmes and management plans for sub-basins to deal with particular aspects of water management that the relevant authorities consider appropriate. In Ireland draft sub basin plans have been created for all *Margaritifera* SAC catchments, but have not been published or updated at the required intervals.

Projects affecting water bodies always require assessment under the WFD.

Sub -Basin Management Plans

The 2009 Regulations set environmental quality objectives for the habitats of the freshwater pearl mussel SAC populations. The Regulations require the production of sub-basin management plans with programmes of measures to achieve these objectives and set out the duties of public authorities in respect of the sub-basin management plans and programmes of measures. These plans must be reviewed and revised every 6 years to incorporate new scientific evidence and new national policies and pressures. To date this has not been done (2023).

GAP Regulations

Farmers in receipt of direct support (e.g., single farm payment scheme) are required to respect certain Statutory Management Requirements (SMRs) and maintain their holdings in Good Agricultural and Environmental Condition (GAEC) as part of their obligations under the conditionality system.

There are eleven SMRs covering climate and the environment, public and plant health, and animal welfare. The SMRs particularly relevant to farming operations in *Margaritifera* catchments include the Water abstraction and protection of waters against pollution caused by phosphates, protection of waters against pollution caused by nitrates, conservation of natural habitats, proper and safe use of plant protection products and sustainable use of plant protection products.

The need to maintain land in GAEC is based on a framework of nine key issues. These include the protection of soil from erosion; the maintenance of soil structure; protecting peatland and wetland, while protecting environmentally sensitive grassland and the protection and management of water.

Compliance with SMR and GAEC obligations is required in all catchments, and are designed to help to ensure sustainable farm practices and responsible stewardship in *Margaritifera* catchments. Failure to comply with SMRs or GAEC may result in a reduction of direct payments.

2.4 Legal Cases and their Implications

There is a significant body of law from the Irish courts and the Court of Justice of the European Union (CJEU) concerning various contested developments which have shaped the interpretation and implementation of European directives in Ireland (e.g., the Habitats Directive) and in some cases have led to changes in statute. The following section aims to highlight key cases and their implications.

2.4.1 Commission of the European Communities v Ireland C-282/02

Under case C-282/02[5], the CJEU found that, in failing to take all of the measures necessary to ensure a correct transposition and application of Council Directive 76/464/EEC (the Dangerous Substances Directive), Ireland had failed to comply with its obligations under Article 7 of that directive.

Directive 76/464/EEC has been amended by Council Directive of 23 December 1991 (91/692/EEC) and Directive 2000/60/EC and corrected by Corrigendum, OJ L 24, 28.1.1977, p. 55. A consolidated text is available. Article 7 states:

Article 7

1. In order to reduce pollution of the waters referred to in Article 1 by the substances within List II, Member States shall establish programmes in the implementation of which they shall apply in particular the methods referred to in paragraphs 2 and 3.
2. All discharges into the waters referred to in Article 1 which are liable to contain any of the substances within List II shall require prior authorization by the competent authority in the Member State concerned, in which emission standards shall be laid down. Such standards shall be based on the quality objectives, which shall be fixed as provided for in paragraph 3.
3. The programmes referred to in paragraph 1 shall include quality objectives for water; these shall be laid down in accordance with Council Directives, where they exist.

[5] https://curia.europa.eu/juris/document/document.jsf;jsessionid=9FCD32D648CDE5A956A2C147DFF62272?text=&docid=60188&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=3498115

4. The programmes may also include specific provisions governing the composition and use of substances or groups of substances and products and shall take into account the latest economically feasible technical developments.
5. The programmes shall set deadlines for their implementation.
6. Summaries of the programmes and the results of their implementation shall be communicated to the Commission.
7. The Commission, together with the Member States, shall arrange for regular comparisons of the programmes in order to ensure sufficient coordination in their implementation. If it sees fit, it shall submit relevant proposals to the Council to this end.

List II of the Dangerous Substances Directive includes certain individual substances and categories of substances "...belonging to the families and groups of substances... which have a deleterious effect on the aquatic environment, which can, however, be confined to a given area and which depend on the characteristics and location of the water into which they are discharged". This includes inter alia "inorganic compounds of phosphorus and elemental phosphorus" and "substances which have an adverse effect on the oxygen balance, particularly: ammonia, nitrites".

According to the NPWS (2011), in response to Case C-282/02, Ireland made the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations (S.I. 296 of 2009), which introduced ecological objectives for the 27 *Margaritifera* populations listed as qualifying interests of SACs in Ireland. Relative to other annexed habitats and species, *Margaritifera* is unique in having the methods for assessing conservation status prescribed in law (O'Connor, 2016).

It should be noted that a later Statutory Instrument S.I. No. 355/2018 - European Union Environmental Objectives (Freshwater Pearl Mussel) (Amendment) Regulations 2018, which purported to amend S.I. 296 of 2009 to remove part of the River Blackwater catchment, was quashed by the High Court on 5 December 2019 by consent of the Minister for Culture, Heritage and the Gaeltacht as a result of proceedings taken by Peter Sweetman (High Court record number 106/18 JR). The quashed instrument, S.I. No. 355/2018, although no longer law, is still to be found online on the electronic Irish Statute Book (eISB) and can be a source of confusion to practitioners unfamiliar with the proceedings.

Article 12 of S.I. 296 of 2009 obligates public authorities, when considering an application for authorisation of a discharge to waters draining to the surface water bodies identified under the First Schedule to the Regulations (i.e. *Margaritifera* catchments), under the Fisheries Acts 1959-2003, the Local Government (Water Pollution) Acts, the Environmental Protection Agency Act, the Waste Management Act, or Regulations made for that purpose under the European Communities Act of 1972 shall, where it is satisfied that the proposed discharge would not contravene Article 6(3) and 6(4) of the Habitats Directive, set down in the authorisation, emission limit values that aim to achieve the ecological quality objectives set out in the Fourth Schedule to these Regulations. These ecological quality objectives require a High Status classified in accordance with the normative definitions of ecological status described in the Water Framework Directive. The effect of this legislation is that for such consent applications the Water Framework Directive objective for the waterbodies in question is 'High' for *Margaritifera* catchments rather than the lower objective status of 'Good' attached to other waterbodies. This is without prejudice to the generality of Regulation 9 or any requirement arising under the European Communities Environmental Objectives (Surface Water) Regulations 2009.

2.4.2 Sweetman v An Bord Pleanála C-258/11 (Opinion of AG Sharpston)

The opinion of Advocate General Sharpston in C-258/11[6] is an authority for the correct interpretation of the screening phase of Appropriate Assessment under Article 6(3) of the Habitats Directive. Under Article 6(3), an AA is deemed to be necessary if the proposal is *likely* to have a *significant effect* on the protected site. AG Sharpston clarified that the word likely used in this context equates to '*possibility of*' and significant effect is an effect somewhere above 'no appreciable effect', acknowledging that *"[t]he threshold at the first stage of Article 6(3) is thus a very low one. It operates merely as a trigger..."*

[6]https://curia.europa.eu/juris/document/document.jsf?text=&docid=130253&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=102796

2.4.3 Sweetman v An Bord Pleanála C-258/11 (Judgment)

In its judgment on Case C-258/11[7], (a case about the effects of the route of the Galway City Outer Bypass roads scheme on limestone pavement, a priority habitat), the CJEU (Third Chamber) set out the test for the second stage of Appropriate Assessment at paragraph 44:

"So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected sites concerned (see, to this effect, Case C-404/09 Commission v Spain, paragraph 100 and the case-law cited). It is for the national court to establish whether the assessment of the implications for the site meets these requirements."

The court ruled that "*Article 6(3)... must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of sites of Community importance, in accordance with the directive. The precautionary principle should be applied for the purposes of that appraisal.*"

This case has laid down strict criteria for Appropriate Assessment, in particular in relation to interpretation of the meaning of 'adverse effect on integrity' of priority habitats. The ruling highlighted that "*the lasting and irreparable loss of the whole or part of a priority natural habitat type whose conservation was the objective that justified the designation of the site concerned as an SCI, the view should be taken that such a plan or project will adversely affect the integrity of that site*".

Applying Case C-258/11 in Eamon (Ted) Kelly v An Bord Pleanála [2014] IEHC 400, Finlay Geoghegan J set out the obligation for the decision maker to give reasons for its determination of an Appropriate Assessment, stating at paragraph 48:

"In accordance with the CJEU decision in Sweetman, it is for the national court to determine whether the appropriate assessment (including the determination) was lawfully carried out or reached, and to do so, it appears to me that the reasons given for the Board's determination in an appropriate assessment must include the complete, precise and definitive findings and conclusions relied upon by the Board as the basis for its determination. They must also include the main rationale or reason for which the Board considered those findings and conclusions capable of removing all scientific doubt as to the effects of the proposed development on the European site concerned in the light of its conservation objectives. In the absence of such reasons, it would not be possible for a court to decide whether the appropriate assessment was lawfully concluded or whether the determination meets the legal test required by the judgments of the CJEU."

In *Kelly*, the High Court found that the unlawful Appropriate Assessment deprived An Bord Pleanala of its jurisdiction to grant planning permission to the development and because of this, and the failure to give reasons, the decision was quashed. Kelly was applied by the Supreme Court in Connelly -v- An Bord Pleanala & ors [2018].

2.4.4 Grace & Sweetman v An Bord Pleanála C-164/17

The facts of Case C-164/17[8] involved a wind farm project in a Special Protection Area designated for the hen harrier under the Birds Directive and incorporated into the Habitats Directive by Article 7 thereof. The development would result in the permanent loss of 9 hectares of habitat and the temporary loss of 1.7 hectares of habitat. The proposal included a Species and Habitat Management Plan, with measures to address the potential effects of the wind farm on the hen harrier's foraging habitat, including the restoration of areas of plantation back to blanket bog. The issue that arose was whether the proposed measures were mitigation measures that could be taken account of under Article 6(3) or compensatory measures appropriate for Article 6(4).

[7]https://curia.europa.eu/juris/document/document.jsf?text=&docid=136145&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=102796

[8]https://curia.europa.eu/juris/document/document.jsf?text=&docid=204392&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=3054212

The CJEU found that the measures in question were not appropriate for satisfying the test in Article 6(3) ruling as follows:

"Article 6 ... must be interpreted as meaning that, where it is intended to carry out a project on a site designated for the protection and conservation of certain species, of which the area suitable for providing for the needs of a protected species fluctuates over time, and the temporary or permanent effect of that project will be that some parts of the site will no longer be able to provide a suitable habitat for the species in question, the fact that the project includes measures to ensure that, after an appropriate assessment of the implications of the project has been carried out and throughout the lifetime of the project, the part of the site that is in fact likely to provide a suitable habitat will not be reduced and indeed may be enhanced may not be taken into account for the purpose of the assessment that must be carried out in accordance with Article 6(3) of the directive to ensure that the project in question will not adversely affect the integrity of the site concerned; that fact falls to be considered, if need be, under Article 6(4) of the directive."

2.4.5 People over Wind & Sweetman v Coillte C-323/17

The facts of Case C-323/17[9] involved works to lay a cable connecting a wind farm to the electricity grid in the catchment of the River Barrow and River Nore SAC, designated for *Margaritifera*. The cabling work was subject to screening for Appropriate Assessment, and was screened out "on the basis of the distance between the proposed Cullenagh grid connection and the European sites, and the protective measures that have been built into the works design of the project".

The CJEC held that this was in breach of Article 6(3) since the Appropriate Assessment Screening took into consideration measures intended to avoid or reduce the harmful effects of a plan or project on the site concerned.

The court ruled that "*Article 6(3) of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that, in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site.*"

Case C-323/17 clarified that measures which are wholly or partially included in order to avoid or reduce impacts to European sites cannot be considered at the first stage (screening) of Appropriate Assessment.

2.4.6 Holohan v An Bord Pleanála C-461/17

This judgment (C-461/17[10]) has important findings for the assessment of species found outside the boundaries of European sites, the extent to which matters can be deferred for future approval under development consents without affecting the Appropriate Assessment or screening carried out prior to consent and the reasons that must accompany an Appropriate Assessment if the decisionmaker disagrees with the report of a scientific expert. It also clarified European law on the scope of assessment of alternatives studied by a developer.

Point1 of the ruling has relevance to both *Margaritifera* and its host fish.

The CJEU ruled as follows:

1. Article 6(3) of [the Habitats Directive] must be interpreted as meaning that an 'appropriate assessment' must, on the one hand, catalogue the entirety of habitat types and species for which a site is protected, and, on the other, identify and examine both the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect the conservation objectives of the site.

[9] https://curia.europa.eu/juris/document/document.jsf?text=&docid=200970&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=3054212

[10] https://curia.europa.eu/juris/document/document.jsf?text=&docid=207428&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=102796

2. Article 6(3) of [the Habitats Directive] must be interpreted as meaning that the competent authority is permitted to grant to a plan or project consent which leaves the developer free to determine subsequently certain parameters relating to the construction phase, such as the location of the construction compound and haul routes, only if that authority is certain that the development consent granted establishes conditions that are strict enough to guarantee that those parameters will not adversely affect the integrity of the site.
3. Article 6(3) of [the Habitats Directive] must be interpreted as meaning that, where the competent authority rejects the findings in a scientific expert opinion recommending that additional information be obtained, the 'appropriate assessment' must include an explicit and detailed statement of reasons capable of dispelling all reasonable scientific doubt concerning the effects of the work envisaged on the site concerned.
4. Article 5(1) and (3) of, and Annex IV to, [the EIA Directive], must be interpreted as meaning that the developer is obliged to supply information that expressly addresses the significant effects of its project on all species identified in the statement that is supplied pursuant to those provisions.
5. Article 5(3)(d) of [the EIA Directive], must be interpreted as meaning that the developer must supply information in relation to the environmental impact of both the chosen option and of all the main alternatives studied by the developer, together with the reasons for his choice, taking into account at least the environmental effects, even if such an alternative was rejected at an early stage.

2.4.7 Eco Advocacy CLG v An Bord Pleanála C-721/21

In Case C-721/21[11], the CJEU considered matters including the *reasons* to be given by the decision maker if, following an AA screening, it is decided that a stage II AA is not required, and also whether *features* that are *incorporated into the project* as *standard features*, irrespective of the European site, which have the effect of removing contaminants and which also may reduce harmful effects, can be taken account of in an AA screening.

The CJEU ruled as follows on these two issues–

"...where a competent authority decides to authorise a plan or project likely to have a significant effect on a site protected under that directive without requiring an appropriate assessment within the meaning of that provision, that authority is not required to respond, in the statement of reasons for its decision, to all the points of law and of fact raised during the administrative procedure, it must nevertheless state to the requisite standard the reasons why it was able, prior to the granting of such authorisation, to achieve certainty, notwithstanding any opinions to the contrary and any reasonable doubts expressed therein, that there was no reasonable scientific doubt as to the possibility that that project would significantly affect that site."

and

"in order to determine whether it is necessary to carry out an appropriate assessment of the implications of a plan or project for a site, account may be taken of the features of that plan or project which involve the removal of contaminants and which therefore may have the effect of reducing the harmful effects of the plan or project on that site, where those features have been incorporated into that plan or project as standard features, inherent in such a plan or project, irrespective of any effect on the site."

The finding of the CJEU in Case C-721/21, that features which involve the removal of contaminants incorporated into the development *irrespective of the European site*, may be taken account of in deciding not to proceed to stage II AA, is not inconsistent with the direction the Irish courts had arrived at in relation to the purpose of measures built into a project. In his judgment in *Sweetman v An Bord Pleanála* [2020] IEHC 39, McDonald J., following an analysis of the Irish and European caselaw to that point, concluded as follows:

"In each case, it is essential to analyse the measures in question in the context of the screening exercise carried out by the competent authority (and any documents relevant to that exercise) and to determine, on an entirely objective basis, whether the measures can be said to have been intended to avoid or reduce harmful effects on a Natura site or whether the measures were designed solely for some other purpose."

[11] https://curia.europa.eu/juris/document/document.jsf;jsessionid=C997751251897F692AE1ECC0FF70FD72?text=&docid=274644&pageIndex=0&doclang=en&mode=req&dir=&occ=first&part=1&cid=29968

The facts of the case before McDonald J. concerned the development of a solar farm on lands in the River Blackwater *Margaritifera* catchment. Judge McDonald, before making his order to quash the planning permission, commented as follows at paragraph 90(f):

"...Based on the content of the CEMP, it is impossible to avoid the conclusion that the purpose of the silt fences and the other protective measures described in the CEMP were intended for any purpose other than the protection of the watercourses draining into the River Blackwater where the various species in that river (including the freshwater pearl mussel) could potentially be adversely affected by ingress of silt-laden water migrating from the construction works on the development site. I do not believe that there is any plausible basis to suggest that the measures were designed to protect the flora and fauna on the development site itself. In light of the contents of the CEMP, and in light of the fact that both the Ardglass and Oakfront streams were off-site, the silt fences cannot have been designed to protect the development site itself..."

Extra care must be taken when interpreting either Case C-323/17 *People over Wind and Sweetman v An Bord Pleanála*, or case C-721/21 *Eco Advocacy CLG v An Bord Pleanála* in the context of significant effects on the conservation of *Margaritifera* for which there are no proven established mitigation measures. Due to the very sensitive nature of *Margaritifera* and the many ways in which damage can occur, or potentially continue to occur in a manner that may prevent restoration, and the individual different conditions and responses of each population, the likelihood of a project being able to be screened out with standard mitigation is very unlikely. Screening out in the case of *Margaritifera* should only occur where there is certainty that no negative effects and no prevention of restoration is possible. If mitigation is required, it would require sufficient evidence.

2.4.8 Peter Sweetman v An Bord Pleanála & Others Case C-301/22 (Opinion of Advocate General Rantos) see also Case C-461/13 *Bund für Umwelt und Naturschutz Deutschland* ECLI:EU:C:2015:433 (the *Weser* case)

At the time this report went to print, the Court of Justice had not yet made its ruling on this reference from the Irish High Court for a preliminary ruling in what is a rare case about the Water Framework Directive. Advocate General Rantos has issued his opinion[12] on the questions referred.

The case concerns small bodies of water, on the specific facts a lake with a topological surface area below 0.5 square kilometres, a threshold mentioned in an annex to the Water Framework Directive. The lake in question, Loch an Mhuilinn is located on Gorumna Island in County Galway and has a surface area of 0.083 square kilometres. The lake had not been characterised by the Environmental Protection Agency as a water body for the purpose of the Water Framework Directive. The issue before the High Court was the question of whether An Bord Pleanála had been obliged to evaluate a project to abstract water from the lake by reference to the requirements of the Directive, when the EPA had not classified an ecological status for the lake, as it considered it to be subthreshold.

It is important to note that the subject matter of Case C-301/22 only concerns water features that the EPA had not considered to be large enough to characterise as surface water bodies for the purpose of the Directive or to classify their status. The CJEU in Case C-461/13 *Bund für Umwelt und Naturschutz Deutschland* (the Weser case) has already clarified that a Member State must refuse authorisation for a project that will impact upon a surface water body if either (a) it will cause a deterioration of the status of the body and/or (b) it will jeopardise the attainment of good surface water status or good ecological potential and good surface water chemical status. The issue in C-301/22 is whether a lake of the scale of Loch an Mhuilinn is a surface water body within the meaning of *Weser* and if not, does it have to be assessed in the context of a development consent application?

The AG in his opinion proposes that the Court of Justice answer the questions referred by the Irish High Court as follows:

(1) Articles 5 and 8 of the Water Framework Directive must be interpreted as meaning that they do not require Member States to characterise and classify all lakes with a surface area below 0.5 km2.

(2) The Water Framework Directive must be interpreted as meaning that in the context of the consent procedure for a project concerning a lake which has not been characterised and classified on account of its

[12] https://curia.europa.eu/juris/document/document.jsf?text=&docid=277638&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=102796

small surface area, the competent national authorities must ensure, by means of an ad hoc analysis, that the project is not capable of causing deterioration in the status of that body of surface water as provided for in Article 4(1)(a)(i) of that directive.

The opinion of the AG that there is an obligation on decision makers to conduct an ad hoc analysis of the impact of a proposed development on the Water Framework Directive objectives is expanded upon somewhat in paragraph 61 of the opinion where he states:

"*61. Accordingly, I take the view that when consent is sought for a proposed development, the competent national authority must determine the ad hoc status of the body of water concerned in order to ensure that that project does not lead to deterioration in its status. To my mind, applying Article 5(1) of Directive 2000/60 by analogy, the Member State must ensure that a review of the impact of human activity on the status of surface waters and an economic analysis of water use are undertaken. That involves establishing evaluation criteria in so far as, in accordance with the case-law of the Court, the obligation to prevent deterioration of the status of a body of water encompasses all changes liable to undermine achievement of the principal objective of that directive. Admittedly, such an examination presents certain practical difficulties if no prior characterisation and classification have been carried out. However, that examination appears to be a necessary step in order to ensure the protection of surface water in the European Union".*

The judgment of the Court of Justice is awaited.

It should be remembered that most if not all rivers where *Margaritifera* are known to exist in Ireland, are already characterised as waterbodies and are classified with a status. This means that in almost all cases involving *Margaritifera*, the principles already decided in Case C-461/13 *Weser* apply. In the Irish context, a 'High Status' objective must be assumed in the context of assessing *Margaritifera* because of the provisions of S.I. 296 of 2009, meaning that a Member State must refuse authorisation for a project involving a water discharge that will impact upon a surface water body if either (a) it will cause a deterioration of the status of the body and/or (b) it will jeopardise the attainment of high surface water status or high ecological potential and high surface water chemical status.

2.4.9 C-444/21 European Commission v Ireland

In Case C-444/21 European Commission v Ireland - 2021/03933[13] infringement proceedings against Ireland, the Court of Justice (Second Chamber) in a ruling given on 29 June 2023 decided the following:

1. that, by failing to designate as special areas of conservation, as soon as possible and within six years at most, 217 of the 423 sites of Community importance, Ireland has failed to fulfil its obligations under Article 4(4) of the Habitats Directive;
2. that, by failing to define detailed site-specific conservation objectives for 140 of the 423 sites of Community importance, Ireland has failed to fulfil its obligations under Article 4(4) of the Habitats Directive; and
3. that, by failing to adopt the necessary conservation measures which correspond to the ecological requirements of the natural habitat types referred to in Annex I and the species referred to in Annex II to the Habitats Directive present on the 423 sites of Community importance Ireland has failed to fulfil its obligations under Article 6(1) of Directive 92/43, as amended.

It should be noted that the Court's findings refer to Ireland's position in January 2019. For example, in respect of site-specific conservation objectives (SSCOs), the case alleges an absence of these at 217 sites, however SSCOs were available for *Margaritifera* SACs before this ruling was made. As of today, SSCOs have been formally identified and published in respect of all 423 sites in the case[14]. Nevertheless, considerable work is required to fully comply with the Habitats Directive in Ireland, particularly in relation to *Margaritifera* where the necessary conservation measures required to achieve the SSCOs for *Margaritifera* SACs have not been adopted. The Director General of the NPWS has stated that "*we will engage with the EU Commission on a roadmap. … It is our firm intention that the judgement will spur NPWS on to further action*"[10].

[13] https://curia.europa.eu/juris/document/document.jsf?text=&docid=275028&pageIndex=0&doclang=EN&mode=req&dir=&occ=first&part=1&cid=324932

[14] https://www.gov.ie/en/press-release/2aa56-judgement-issued-by-cjeu-on-case-c-44421-eu-commission-v-ireland/

2.4.10 Conclusions

This section summarises key legal cases that have already, and in the case of C-444/21 Commission v Ireland likely will, shape the interpretation and implementation of the Habitats Directive in Ireland. Knowledge, understanding and application of all aspects of Appropriate Assessment are subject to emerging case law, and it is important that relevant case law from both the Irish and European courts is considered as part of any assessment concerning Natura 2000 sites. This report does not contain legal advice and should not be relied upon as such.

3 ASSESSING THE POTENTIAL IMPACTS OF PLANS OR PROJECTS IN CATCHMENTS WITH *MARGARITIFERA* WHOSE POPULATIONS ARE DESIGNATED AS QUALIFYING INTERESTS IN SACS THROUGH APPROPRIATE ASSESSMENT

3.1 Where Can Impacts Occur in a Project

A Cradle – to - Grave approach is needed in the assessment of potential impacts.

The longest stage of a project is generally the operational phase, so it is obvious that any project that would have a negative effect with reference to the Conservation Objectives that would prevent or delay the restoration of the ecological requirements of *Margaritifera* should not be permitted. In order of assessment this should come first, before a large amount of project design effort is undertaken. For example, the day-to-day operation of a housing estate would include the quantity of clean and waste water involved, its source and treatment destination. Management and maintenance of buildings and roadways, green areas and habitats created. The infrastructure for the project should be fully assessed. Permanent changes to the current operating environment such as excavation of soil and replacement with engineered foundations, changes to landscaping, drainage levels, filtration capacity to the soil or water storage capacity in the soil. Any project that would have a negative effect with reference to the Conservation Objectives that would prevent or delay the restoration of the ecological requirements of *Margaritifera* should not be permitted. If the permanent environmental changes and operational stage of the project is benign, then the assessment moves to whether the project can be constructed safely. More temporary elements of construction including soil disturbance and contaminated water management must be demonstrated to be manageable, and that responsibility for the safe management from start to finish and its documentation is clear.

3.2 Where Can Information on the *Margaritifera* Population be Found

For the purposes of Appropriate Assessment (AA) under Article 6(3) of the Habitats Directive, typically only *Margaritifera* populations listed as qualifying interests for Special Areas of Conservation (SACs) are considered. It is important to note, however, that as per case C-461/17 *Holohan and others v. An Bord Pleanála*[15], *"Article 6(3) of the Habitats Directive must be interpreted as meaning that an 'appropriate assessment' must, on the one hand, catalogue the entirety of habitat types and species for which a site is protected, and, on the other, identify and examine both the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect the conservation objectives of the site."* Therefore, an AA must identify and examine the implications of a proposed project or plan on *Margaritifera* populations outside the boundaries of an SAC, provided those implications are liable to affect the conservation objectives of the SAC. Section 4.1 below provides details on where information on these *Margaritifera* populations can be obtained.

Spatial data for SACs in Ireland can be downloaded for free from the NPWS website (Table 3.1). Furthermore, *Margaritifera* SACs can be viewed on the EPA AA GeoTool. The AA GeoTool application can assist with the data gathering process for screening for AA and for AA. The EPA and the NPWS have developed the AA GeoTool and the application uses data provided by the NPWS[16].

Spatial data on the Site-Specific Conservation Objectives (SSCOs) for *Margaritifera* populations listed as qualifying interests for SACs is also available from the NPWS, and can be viewed on the SSCO web tool published by the NPWS (Table 3.1).

Information on the distribution and abundance of *Margaritifera* populations within SACs can be requested from the NPWS via a sensitive biodiversity data request. Furthermore, reference can also be made to the sub-basin management plans that have been produced for *Margaritifera* to act alongside the wider River Basin Management Plans (RBMPs) to provide a programme of measures required to improve the habitat of *Margaritifera* so that it can attain favourable conservation status. Note, however, that these plans were

[15] https://curia.europa.eu/juris/document/document.jsf?text=&docid=207428&doclang=EN

[16] https://epawebapp.epa.ie/terminalfour/ApproAssess/index.jsp

prepared as part of the 1st cycle of River Basin management Plans for 2009-2015, and were not updated as part of the 2nd or 3rd cycles, resulting in gaps where more detailed requirements now known for *Margaritifera* should be updated.

Table 3.1. Spatial information sources for *Margaritifera* in Ireland.

Dataset/Resource	Source	Link	Access
Freshwater pearl mussel (*Margaritifera margaritifera*) Sensitive Areas	NPWS	https://www.npws.ie/maps-and-data/habitat-and-species-data	Free to download from website.
Biodiversity Maps	NBDC	https://maps.biodiversityireland.ie/Map	Free to view on website. Some of the source datasets can be downloaded for free.
SAC Boundary Data	NPWS	https://www.npws.ie/maps-and-data/designated-site-data/download-boundary-data	Free to download from website.
Freshwater pearl mussel catchment/distribution target/suitable habitat (Site Specific Conservation Objectives - SSCO)	NPWS	https://www.npws.ie/maps-and-data/habitat-and-species-data	Free to download from website.
Nore freshwater pearl mussel (Species Specific Conservation Objectives - SSCO)	NPWS	https://www.npws.ie/maps-and-data/habitat-and-species-data	Free to download from website.
SSCO Map Viewer	NPWS	https://dahg.maps.arcgis.com/apps/webappviewer/index.html?id=63b6a14f5b164b289ad87048f71532b8	Free to view on website.
Population Data	NPWS	https://www.npws.ie/maps-and-data/sensitive-data-access	Can be requested as part of a sensitive data request.
Sub-basin Management Plans 2009-2015	EPA	https://www.catchments.ie/download/freshwater-pearl-mussel-plans-2009-2015/	Free to download from website.

3.3 What Gaps in Information Need to be Filled

Margaritifera is sensitive to a myriad of pressures including changes in hydrology and hydromorphology, nutrient enrichment and siltation, all of which may arise from developments or activities within a river catchment. Accordingly, conservation and protection of the species must occur at the catchment level. Impact assessment of plans or projects on *Margaritifera* must also be undertaken at the catchment level.

Key information gaps that need to be addressed as part of any assessment of the impact of a plan or project on *Margaritifera* within an SAC include:

- Whether the plan or project is directly connected with or necessary for the management of the site as a European Site
- Whether the plan or project is within or connected to a catchment that contains an SAC for which *Margaritifera* are listed.
- Identification of the potential sources and pathways for impact on the *Margaritifera* population, which should be informed by:
    - Detailed information about the project or plan.
    - Hydrological and hydrogeological context of the project or plan.

- Technical information on the construction design and implementation of the construction phase.
- Technical information on the operational stage of the plan or project.
- The checklist of questions outlined in Table 8 of the CEN standard for *Margaritifera* (NSAI, 2017) which should be asked where short-term activities or long-term plans or projects are being assessed for potential damaging effects on a *Margaritifera* population.

- Identification of the potential impacts of the project or plan on *Margaritifera* during both the construction and operational stages, in light of the conservation objectives of the SAC.
- Identification of whether the project or plan will prevent, cause delays in or interrupt progress towards achieving the conservation objectives of the site (e.g., could the plan or project prevent the restoration of the *Margaritifera* population?).
- Identification of whether evidence-based avoidance or mitigation measures can be implemented to reduce or eliminate, any potential impacts of the project or plan on the conservation objectives of the *Margaritifera* population within the SAC.
- Assessment of the effectiveness of proposed mitigation and avoidance measures.
- Identification and incorporation of monitoring requirements into mitigation measures.
- Identification of residual impacts.

3.4 What Information is Needed about the Plan or Project in Order to Make an Assessment

The following series of questions are intended to provide focus for key issues relating to a *Margaritifera* related Habitat Directive assessment specific to a particular plan or project. The questions will help to ensure that the assessment is complete and without gaps, considers risks relevant to *Margaritifera*, and may alert both regulators and project and plan developers to possible gaps and deficiencies.

Note that the list of questions is not exhaustive, and the information provided in Section 3 provides more explicit and focused questions relating to particular sectoral activities that will assist in undertaking a Habitats Directive assessment.

3.4.1 Plans

It is important to consider any plan on a holistic basis to ensure that all elements of the plan and associated strategies are considered in the assessment. The following questions should be considered at the plan level when assessing the potential impact on *Margaritifera* SAC Catchments.

Is the plan to be completed in stages?

If yes, then all stages of the project need to be assessed before commencing any works. Failure to make an adequate assessment of the later project or plan stages at the outset poses a risk that future assessments will determine that they may not proceed.

Is the plan part of a larger strategy or series of work packages?

If yes, then the potential for cumulative impacts need to be assessed since later assessments could mean other elements of the strategy or work programme may not be allowed to proceed.

Does the plan require access through an *Margaritifera* SAC catchment?

If yes, the adequacy of access roads, the nature of material being transported (e.g., uncovered loads of lime rich aggregate or stone), and potential for impact on *Margaritifera* populations should be considered.

Are alternative options available for the plan that eliminate potential impact on *Margaritifera*?

If alternative sites are available that are not connected to *Margaritifera* SAC catchments, then preference should be given to these sites since mitigation of impact is not an easy matter in *Margaritifera* SAC catchments.

3.4.2 Projects

3.4.2.1 Project Splitting

Given the susceptibility of *Margaritifera* to cumulative and in-combination effects, the assessment must be comprehensive, encompassing all aspects of the wider project activities, and should not be narrowed to the extent that it could be considered to be "project splitting". It is essential that the full potential impact of a project or plan is assessed, including any future consequences that are likely to arise from that activity. In this regard it is important that the longevity of the *Margaritifera* and its breeding strategy, which entails high mortality rates of larval mussels, are considered. This requires that the full details of the entire project must be available before any decision on potential impact and consent can be reached.

3.4.2.2 Phased Projects

It may be difficult or impossible to carry out a full assessment for major phased projects. For example, a wind farm application for a number of turbines may not know the full details of future network connections at the time of application. In such cases all parties should be aware that future applications will require Habitats Directive assessment, including all cumulative and in-combination effects, with no guarantee of consent to proceed.

3.4.2.3 "Design and build"

In the case of "design and build" type approaches, it is not possible to complete a Habitats Directive assessment for *Margaritifera* SACs until the full detail of ALL works is available, and project proponents may wish to consider the implications of this during procurement and contract preparation.

Thus, a full assessment with no gaps is the required approach by which a project can be considered with regard to Article 6.3 of the Habitat's Directive. In order to assess site locations, works areas, construction methods and mitigation measures, the exact location, design, hydrology, hydrogeology, soil type, and nutrient levels need to be considered for in-combination effects, This includes the need for detailed method statements, full designs, clear detailed scale drawings that document the construction process from start to finish.

3.4.3 Not directly connected with or necessary to the management

The EU Guidance Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (EU, 2019) established that in the context and purpose of Article 6, the term 'management' is to be treated as referring to the 'conservation' management of a site, i.e., it is to be seen in the sense in which it is used in Article 6(1).

"Necessary to" can be defined as that which is required to achieve the conservation objectives, for example:

- erection of a fence to prevent cattle grazing an area from disturbing ground nesting birds in an SPA;
- blocking of ditches to restore water tables on raised bog SAC;
- culling deer to prevent overgrazing of woodland or heathland.

"Directly connected with" can be defined as an associated operation, which needs to be carried out to achieve a necessary objective, for example:

- carrying out certain survey work to better understand the management required for the effective conservation of the qualifying interest(s) of the site (or suite of sites)
- erection of fence to control grazing where woodland regeneration is poor.

Thus, if an activity is directly connected with and necessary for fulfilling the conservation objectives of a European Site, it is exempted from the requirement for an assessment.

This will only rarely be applicable to development control and will be a more important consideration for other authorisation procedures such as consents under the Wildlife Act, Habitat Regulations, protected species licensing, and land management plans and projects for nature conservation. It should be noted that there will be cases where conservation management proposals which benefit one qualifying interest may be at the

expense of another. Remember that when assessing any conservation management proposals where European sites or species overlap, the effects on all the qualifying interests of all sites must be considered.

By introducing the possibility of establishing management plans, Article 6(1) envisages flexibility for Member States as regards the form such plans can take. The plans can either be specifically designed for the sites or 'integrated into other development plans'. Thus, it is possible to have a 'pure' conservation management plan or a 'mixed' plan with conservation as well as other objectives.

The words 'not directly connected with or necessary to...' ensure that a non-conservation component of a plan or project which includes conservation management amongst its objectives may still require an appropriate assessment.

3.4.4 Key issues relating to an assessment of a plan or project on *Margaritifera* populations

The following series of questions are intended to provide focus for key issues relating to a *Margaritifera* related assessment specific to a particular plan or project. The questions will help to ensure that the assessment is complete and without gaps, considers risks relevant to *Margaritifera*, and may alert both regulators and project and plan developers to possible gaps and deficiencies.

Note that the list of questions is not exhaustive, and site-specific questions will be required within the individual catchment under consideration. There will also be the requirement to provide more explicit and focused questions relating to particular sectoral activities that could also assist in undertaking an assessment of the potential impact on *Margaritifera*.

The series of questions in Table 3.2 are taken from the CEN European Standard - Water quality - Guidance standard on monitoring freshwater pearl mussel (*Margaritifera margaritifera*) populations and their environment and should be asked where short term activities or long terms plans or projects are being assessed for potential damaging effects on a *Margaritifera* population. These questions apply to activities in the catchment, where they could affect the river.

These questions need to be asked with respect to the conservation objectives of a population, usually "restore". It requires assessment of projects that may previously been regarded as continuation of the status quo, such as a new agricultural scheme following on from an older one, or for felling and replanting forestry, or demolishing and rebuilding structures including roads. The consideration of alternatives that allow for restoration of habitat function must be the basis for assessment.

Table 3.2: Checklist of questions that should be addressed to ensure that plans or projects do not damage *Margaritifera* populations

Aspect	Question
Mussel Population	Will the plan or project result in humans, animals or equipment entering the river?
	Has the plan or project the potential to affect the annual reproductive cycle of the mussels?
	Will the plan or project increase the risk of pearl fishing, or direct disturbance to mussel beds?
Fish hosts	Has the plan or project the potential to affect the upstream or downstream migration of salmonids, including the timing of their movements?
	Has the plan or project the potential to affect the distribution or numbers of salmonid fish in the catchment?
	Has the plan or project the potential to affect the quality and distribution of salmonid spawning habitat?
	Has the plan or project the potential to affect the species composition of fish in the river?
Non-native species	Has the plan or project the potential to introduce or encourage the spread of non-native species to the river or catchment?
Water Quality	Will there be a new outfall or changes to an established outfall entering the river?
	Will changes to land management have the potential to increase nutrient loading to the river?
	Will the plan or project result in the concentration of nutrients that are currently more dispersed?
	Will any aspect of the plan or project potentially affect the temperature regime of the river?
	Will the plan or project change the pH of the water?
	Will any fertilizers be needed to establish or continue the project?
	Will the plan or project result in more intensive use of the catchment?
	Will the plan or project result in greater wastewater production in the catchment (increased human or animal loading)?
	Will any pesticides be needed to establish or continue the project?
	Will any potentially toxic substances be used in or generated by the project that would be damaging if they were to enter the river?
	Has the plan or project the potential to change the water quality of the river in any other way
Flow	Are there planned abstractions, or changes to abstraction levels or compensation flows?
	Will any planned changes in land management indirectly result in changes to the flow regime of the river?
	Is there any modification to drainage, or dewatering associated with the plan or project?
	Will any modification have the potential to change the stability conditions of the river bed?
	Has the plan or project the potential to affect the flow regime in the river in any other way?
Substrate Quality	Has the plan or project the potential to increase fine sediment loading to the river or within the river?
	Could works affect the supply of coarse sediment to the river?
	Will the plan or project potentially lead to erosion or bare soil in the catchment or directly adjacent to the river?
	Is there any new drainage or drainage maintenance associated with the plan or project?
	Are any instream works planned (e.g. gravel removal)?
	Are any structures planned close to the river, within or across the river (e.g. installing flow deflectors)?
	Are there any bank reprofiling or bank engineering plans?
Riparian landuse	Has the plan or project the potential to affect the nature of the riparian habitat in the river?
	Has the plan or project the potential to affect the nature of the floodplain?
Vibration and drilling / blasting /noise	Has the plan or project the potential to affect the mussels or their hosts through damage arising from vibration and drilling / blasting /noise?

3.5 Technical Information on the Operational Stage of The Project Needed to Make an Assessment

Some of the key issues and questions to be answered on the nature of the development during its operation are listed below with an explanation as to why they are important in the assessment of the potential impacts on *Magartifera* in SAC catchments.

3.5.1 Operations

Will the proposed development result in new access roads, hard impermeable surfaces, including roofs etc. that require drainage systems?

An increase in impermeable surfaces results in significant changes to catchment hydrology. Natural flow regimes may be altered with resulting impact on downstream *Margaritifera*. Sediment and nutrient release, and pollutant load to waters is increased.

Will the proposed development result in aerial or liquid emissions?

Margaritifera is a species that requires pristine water and riverbed habitat. Emissions of any kind must be strictly regulated to ensure that environmental quality objectives that are supportive of it reaching favourable conservation status are achieved. This may require elaborate treatment or off-site removal of effluents, particularly in headwater *Margaritifera* catchments where adequate dilutions may not be available. The regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before proceeding.

Is the proposed development likely to create hydrological pressures in the catchment and changes in the flow regime?

Water abstraction, physical modifications and impoundments will inevitably result in alterations to discharge volume and water velocity. Both are critical elements which need to be maintained at optimum levels in order to maintain *Margaritifera* at favourable conservation status. Low flow conditions can also exacerbate the impact of nutrients arising from other land uses due to inadequate dilution.

Will the proposed development require regulation of flows in the catchment?

If yes is the answer, this activity may pose a high risk to the *Margaritifera* because of unnatural flow regimes, with consequent changes in water temperature, oxygen levels, pollutant concentrations silt deposition and algal growth. High discharge rates from impoundments may also result in damaging downstream water velocities.

Will the proposed development entail water abstraction from a lake within the *Margaritifera* catchment?

If yes is the answer, water abstraction from managed lakes can result in extreme and protracted low flows downstream in the catchment. This may result in severe impact on any downstream *Margaritifera* populations.

Will the activity entail flow regulation, or abstraction from a river?

If yes is the answer, flow regulation and water abstraction of any scale from a river poses a high risk to the *Margaritifera* due to reduced downstream flow velocity and wetted areas, elevated temperatures causing lower oxygen levels, increased sediment deposition and growth of algae and macrophytes. Unnatural flows may also interfere with the *Margaritifera* reproductive cycle. Reviews of discharge consents should consider the requirement for a Habitats Directive assessment in *Margaritifera* SAC catchments. Abstractions may alter seasonal flow patterns and wetted areas with impacts on *Margaritifera* reproduction and survival.

Does the proposed plan or project involve any potential changes to groundwater levels, abstractions from, or emissions to groundwaters?

Changes to land cover, land use, groundwater composition and quantity may manifest in surface waters, possibly some distance from the groundwater abstraction or discharge site, and possibly in another surface water catchment.

Is the proposed activity part of drainage maintenance works?

If yes is the answer, drainage works can cause direct mortalities in *Margaritifera* populations and loss of habitat, particularly suitable juvenile mussel habitat. Long term alterations in the flow and velocity regime of the river system can be damaging to mussels for many years.

Are new drains proposed?

If yes is the answer, this activity may pose a high risk to the *Margaritifera* because it alters hydrology, sediment movement and nutrient movement. Drainage of peat and peaty soils can also increase the levels of dissolved organic carbon reaching the river system and lead to significant impact on *Margaritifera*. Blanket bog is the natural vegetation of the upper catchments in many *Margaritifera* areas. Blanket bog acts like a sponge, regulating the flow of water in the catchment. Drainage or removal of peat for development has the capacity to drastically change the hydrology of the upper catchment. The regulatory authority must be completely satisfied that adequate measures with proven capacity for removal of risk are to be implemented before permission for the drainage works is granted.

Are existing drains to be altered or maintained?

If yes is the answer, this activity may pose a continued and potentially enhanced high risk to the *Margaritifera* just as for new drainage above. Existing drains may already be contributing to the unfavourable condition of a *Margaritifera* population, and where regulatory approvals are required; the regulatory agency must be completely satisfied that adequate measures with proven capacity for removal of risk are to be implemented before permission for the development is granted. Existing drainage may need to be remediated as part of the conservation objective to "restore".

Are there physical modifications associated with the proposed development that could act as a barrier to mussels or their salmon and trout host species?

If the answer is yes, the barriers may prevent fish migration and result in disruption of the *Margaritifera* breeding cycle, and may prevent dispersal of mussels in the system. The regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before proceeding.

Are there physical modifications associated with the proposed development that could act as a barrier to the natural movement of river bed substrate downstream from upstream areas or from high energy tributaries?

If the answer is yes, there can be severe negative consequences for *Margaritifera* habitat quality due to stable riverbed substrate not being replaced, and over time becoming concreted or destabilized and unsuitable for pearl mussels. Such barriers must not be permitted upstream of *Margaritifera* habitat.

Is it proposed to upgrade or develop a new facility for water and/or wastewater treatment in an *Margaritifera* catchment?

Even low levels of suspended solids and nutrients in discharges from treatment facilities associated with developments or as part of the public urban wastewater treatment are likely to have adverse effects on water quality in high status *Margaritifera* catchments. Water and wastewater treatment facilities must be capable of treating effluents to standards that will not impair the conservation status of *Margaritifera*. Any proposal to develop or upgrade such facilities must be subject to a full risk assessment. Alternatives, including relocating treatment facilities or their discharges outside the *Margaritifera* catchment must be given serious consideration.

Will the project generate waste or sludges?

Inappropriate handling of waste and sludge arising during construction and operation/maintenance phase of a proposed development poses a serious risk to *Margaritifera*. Disposal of road sweepings and sludges are a particular risk and such activities should not take place in *Margaritifera* catchment areas.

Will the proposed activities require fertiliser application?

If yes is the answer, fertiliser application in *Margaritifera* catchments poses a high risk to the sustainability of *Margaritifera* populations which require very low nutrient (oligotrophic) conditions. Nutrient loss at the time of fertiliser application, and from decaying brash when crops are harvested can result in significant impact to *Margaritifera*. Fertiliser application for existing or new stands in sensitive areas must be avoided or managed appropriately.

3.5.2 Services

Will the proposed development require provision of new or expanded services such as Roads, Water/Wastewater, Power Generation/Supply etc. which may be located outside the main development site and in an *Margaritifera* catchment?

The provision of services may require works and infrastructure located in, or crossing through *Margaritifera* catchment areas to the proposed development site, e.g. water, wastewater, roads/traffic, electricity generation/transmission systems (pylons etc), communication systems (masts and poles), gas pipelines, together with waste disposal facilities. These services may impact on *Margaritifera* both during construction and/or operation.

3.6 Technical Information on Construction Design and Implementation Needed to Make an Assessment

Some of the key issues and questions to be answered on the nature of the development during its planning and construction stages are listed below with an explanation as to why they are important in the assessment of the potential impacts on *Magartifera* in SAC catchments.

The series of questions and answers in section 3.5 will apply to the construction of developments in SAC catchments, some of the key issues are outlined below.

3.6.1 Planning

Is the project or plan to be completed in phases?

If yes, then all stages of the project need to be assessed before commencing any works. Failure to make an adequate assessment of the later project or plan stages at the outset poses a risk that future assessments will determine that they may not proceed.

Is the project or plan part of a larger strategy or series of work packages?

If yes, then the potential for cumulative impacts need to be assessed since later assessments could mean other elements of the strategy or work programme may not be allowed to proceed.

Does the plan or project require access through an *Margaritifera* catchment?

If yes, the adequacy of access roads, the nature of material being transported (e.g., uncovered loads of lime rich aggregate or stone), and potential for impact on *Margaritifera* populations should be considered.

3.6.2 Site Characteristics in a construction context

If the operational stage can be safely managed, the consideration must then move to whether the project can be safely constructed. **Some of the key issues and questions to be answered on the nature of the development during its planning and construction stages are listed below with an explanation as to why they are important in the assessment of the potential impacts on *Margartifera* in SAC catchments.**

Is the proposed development adjacent to a river, stream or lake?

If yes is the answer, the development construction will pose a much higher risk of nutrient and fine sediment losses to water, and of changes to hydrology. In such sites prevention of damage is extremely difficult, and development and associated infrastructure development should avoid them.

Has a detailed audit of the drainage network indicated significant risk to the *Margaritifera* and its habitat through drainage pathways?

If yes is the answer, the potential for hydrological change and erosion in the area between the proposed development site and the river, and risks to the *Margaritifera* population must be assessed. Where peat or other easily eroded soils are present along drainage pathways the risk is exacerbated. Where peat extraction on sites with such drainage features is required, it must be carefully planned, and managed in a manner that mitigates all significant risk. If risks cannot be removed the proposed development should not proceed.

Does the proposed site have impermeable soils, highly erodible soils such as peat, or a high water table?

If yes is the answer, the development will pose a much higher risk of nutrient and fine sediment losses to water, and of changes to hydrology. In such sites mitigation to prevent damage is extremely difficult and may well be insurmountable and prevent the project proceeding. Onsite sewage treatment for example may not be possible in certain circumstances. Any proposed new development should clearly detail the measures being proposed to prevent such impacts. Existing development on such soils must be carefully managed in a manner that mitigates significant risk. Areas where peat soils are common pose particular problems for proposed developments.

Are there steep slopes (greater than 1 in 7 or 15%) within your proposed development /operational area or in the drainage pathway to the river that represent a significant risk to the *Margaritifera*?

If yes is the answer, these steeper slopes may lead to greater soil erosion and more rapid nutrient loss because surface runoff is faster. Avoid development and associated infrastructure on such slopes, and on level areas draining down steep slopes as safe construction cannot be guaranteed.

Will the proposed site require extensive ground works including landscaping, vegetation/scrub removal?

Such works may include cut and fill operations, contour reprofiling, and excavations. They create areas of exposed soil and spoil heaps that can lead to sediment and nutrient in run off to the aquatic zone. The removal of vegetation and scrub also leads to increased loss of sediments and nutrients to watercourses.

Will the proposed development require significant new, or altered drainage?

Rainwater collected in drainage systems flows rapidly via outfalls into receiving waters at high volume compared to natural drainage through land and vegetation. This can create scouring and flash flooding in rivers downstream of the discharge.

Is there potential for soil erosion along the drainage pathways from the proposed development/operational area?

If a potential for soil erosion exists due for example to the presence of peaty soils or steep slopes (greater than 1 in 7 or 15%) along drainage pathways, there is potential for greater erosion in the area between the proposed development site and the river, and risks to the *Margaritifera* population must be assessed.

3.6.3 Construction

Will site preparation works involve significant excavation, deep foundations, pile driving, or the removal and disturbance of soil?

Construction by its nature involves the disturbance of soils and in many cases removal of rock outcrop or underlying strata in order to provide a site suitable for the proposed development. Such works which may include cut and fill operations, contour reprofiling, and excavations. This increases the risk of sediment and nutrient movement to watercourses. During construction, newly laid foul and surface water drains can provide a pathway for sediments and nutrients to watercourses. For activities involving soil disturbance the regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before permission is granted for the development or associated infrastructure.

Will the construction works involve the storage on site of stockpiles of soil, or other material excavated or stripped during site preparation for later reuse such as landscaping?

Stockpiled material, particularly soil for later landscaping, is likely to create run off containing sediments and/or nutrients. Stockpiles should be carefully sited and managed to prevent contamination of watercourses.

Will construction materials be stored on site that may prove a threat to *Margaritifera* populations?

During construction many varied materials may be used in both liquid and solid form including hazardous chemicals such as adhesives, surface coatings, and preservatives to inhibit corrosion and/or biological attack. The storage and subsequent use of such materials must be carried out in a manner that prevents any spillage, runoff, or loss due to equipment cleaning to waters.

Will limestone or lime rich materials be used in ballast or construction materials?

The use of such material in quantities and at locations where it can affect the pH of surface and ground waters can result in significant impact and toxicity to *Margaritifera* over many years. Appropriate material should be used to mitigate against this impact.

Is it proposed to divert surface waters during construction?

Diversion of surface waters is a high-risk activity that may impact on the natural flow in nearby watercourses and result in impact on *Margaritifera* due to scouring, drying of the bed, alteration in the delivery of detritus a food source for juvenile mussels in particular, changes in oxygen levels and temperature, and sediment and nutrient pollution. Such action requires prior regulatory approval, and the regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before permission is granted.

Will dewatering of trenches and excavations be required?

Groundwater pumped out of underground or excavated areas to facilitate construction must be adequately treated or removed off site to prevent sediment and nutrient contamination of watercourses. It must be demonstrated that it will not negatively affect flow velocities at *Margaritifera* habitat.

Is it proposed to develop a temporary compound for construction within a *Margaritifera* catchment?

Site compounds for large construction projects can require significant ground preparation during initial site set up. The storage of fuel, oils and other chemicals is often undertaken at the site compound as is waste management, recycling and materials storage. Any site compound within a *Margaritifera* catchment must have adequate protection to prevent pollution. Any such site must be subject to risk assessment including the transport of materials to and from such sites.

Is it proposed to provide on-site refuelling of vehicles and equipment used in construction?

Oil pollution caused by the failure of storage facilities or careless refuelling practices is a common source of water pollution. Adequate mitigation measures must be in place before proceeding.

Will the site preparation and construction works involve the movement of vehicles over unpaved erodible surfaces, particularly any such areas near watercourses?

Movements of vehicles and equipment over exposed rough ground will cause both sediment and nutrient loss due to the disturbance of the soil. Soil compaction can also create new pathways for rapid and unpredictable water movement which is difficult to manage. Vehicles should be excluded from sensitive areas using physical barriers such as fencing or ropes.

Does the construction require machinery to access watercourses or require fording or temporary platforms to be constructed in the channel?

Construction and repair of fords or working platforms can result in release of damaging amounts of sediment downstream. Use can also result in sediment and other pollutant release, and may cause direct damage to mussels at the crossing point. Fords and working platforms can also result in changes to flow and barriers to migration of host fish that are essential to completion of the *Margaritifera* life cycle.

Is it proposed to carry out any in-stream, or river bankside works?

This includes the installation of pipes and other services, and works associated with drainage or abstraction along river banks and the building of any structures such as micro hydroelectric power systems. Such activities pose a very high risk of damage to *Margaritifera* and its habitat and should be avoided. The regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before proceeding.

Will the proposed development require bridge works to provide site access during construction or operation?

Bridge construction, or upgrade, and subsequent maintenance constitute a high risk to *Margaritifera* through damage to the channel and bank structure, the riparian zone, and/or hydrology of the river. The regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before proceeding.

Is it proposed to use local "borrow pits" to provide construction material?

For larger developments, e.g., road development taking place in more remote rural areas, use may be made of materials extracted from "borrow pits" close to the location of the new road. This practice should seek to avoid *Margaritifera* catchments where it poses a high risk of contaminated run off entering local watercourses and damaging *Margaritifera* habitats present. The regulatory authority must be satisfied that adequate mitigation measures with proven capacity for removal of risk are to be implemented before permission is granted.

Is it proposed to construct (and maintain) flood defence infrastructure?

The construction and operation of flood defences, including walls or other forms of barrier, associated with any proposed project can radically alter the flow regime in a river system, leading to damage to any *Margaritifera* habitat present. The regulatory authority must be satisfied that the design of the structure is safe for the hydrological regime of the population, and that adequate mitigation measures with proven capacity for removal of risk are to be implemented before proceeding.

Will the proposed development result in deposition of dust or airborne contaminants?

The *Margaritifera* is a species that requires pristine water and riverbed habitat. Construction activities particularly associated with development of large sites can be a source of dust or other airborne contaminants which can impact on water quality if deposited or washed into waters as a result of rainfall. In the case of roads the transport of certain material can also lead to airborne dust and particulates. This can be especially significant if such deposition is allowed to take place over long periods of time. Mitigating measures must be put in place to prevent such events occurring.

Construction involving tree felling and tree planting, agricultural modification and bog restoration

The methodologies through which the construction or modification activities are undertaken require very different, site-specific approaches. It must be demonstrated that the approach proposed is the most appropriate in each case and location.

3.7 The Appropriate Assessment Screening Process

The Habitats Directive (92/43/EEC) provides legal protection for habitats and species of European importance. Article 6(3) and (4) of the directive set out a series of safeguards governing plans and projects likely to have a significant effect on a European Site. A key protective measure is the requirement for every proposed plan or project to undergo an assessment of its implications for any European Site before the project or plan can be authorised by the competent authority (OPR, 2021). Consent for the project or plan can only be given after determining that it will not adversely affect the integrity of the Site(s) concerned in view of the conservation objectives of that Site.

Article 6(3) states:

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public."

In order to determine if an AA is required, a 'screening' process must first be carried out for applications for planning permission. The purpose of this 'screening' stage (often referred to as "stage 1") is to determine whether a plan or project is directly connected with or necessary for the management of the European Site(s), or whether a plan or project, alone or in combination with other plans and projects, is likely to have significant effects on the European Site(s) in view of its conservation objectives. If it cannot be excluded, on the basis of objective information, that a plan or project will have a significant effect on European Site(s), either individually or in combination with other plans or projects, then the plan or project must be subject to an AA (stage 2).

Appropriate Assessment screening can be carried out in four steps (EC, 2022):

1. Determining whether the plan or project is directly connected with or necessary to the management of a European Site;
2. Identifying the relevant elements of the plan or project and their likely impacts;
3. Identifying which (if any) European Sites may be affected, considering the potential effects of the plan or project alone or in combination with other plans or projects;
4. Assessing whether likely significant effects on the European Site can be ruled out, in view of the Site's conservation objectives.

The likelihood of there being a significant effect on a European site from a plan or project will trigger the need for an AA. This test is based on the precautionary principle, i.e., where significant effects are likely, uncertain or unknown at screening stage, AA will be required (DEHLG, 2009). This conclusion may be reached without an in-depth screening, and could be determined with consideration of the type, size or scale of the plan/project, or the characteristics of the European site (EC, 2022).

3.8 How to Determine whether a Plan or Project is 'Likely to have a Significant Effect Thereon, either Individually or In Combination with Other Plans or Projects'

3.8.1 Likely to have

Determining whether a project or plan is 'likely' to have a significant effect on a European site is based on an impact assessment using available information and data, supplemented as necessary by local site information and ecological surveys (DEHLG, 2009). Importantly, the use of the word "likely" ensures that that the triggers for AA are based on the *likelihood* or *possibility* of a potential significant effect occurring, and not on certainty (OPR, 2021).

In order to determine the potential for likely effects, in the first instance it is recommended that the Zone of Influence (ZoI) of a proposed plan or project is established. The ZoI of a proposed plan or project is the geographical area over which it could affect the receiving environment in a way that could have likely effects, directly or indirectly on European Sites. The potential for likely significant effects can be established using a Source-Pathway-Receptor (S-P-R) model. As part of this mechanism, for an effect to be likely, all three elements of it must be in place. The absence or removal of one of the elements of the model results in no likelihood for an effect to occur.

3.8.2 Significant effect

The EC (2021) defines a significant effect as "*any effect that may reasonably be predicted as a consequence of a plan or project that would negatively and significantly affect the conservation objectives established for the habitats and species significantly present on the Natura 2000 site*". Such significant effects can arise from activities on-site, off-site or as a result of in-combination effects with other plans and projects. The significance of an effect on a European Site will be context dependent and will vary depending on a number of factors including the magnitude of impact, the type, extent, duration, intensity, timing, probability, cumulative effects and the sensitivity of the habitats and species concerned (EC, 2021).

In determining significance, it is essential that each plan or project is assessed on a case-by-case basis. Determining the 'significance' of likely effects relies on the assessment of objective, scientific information (OPR, 2021). The assessment must cover all the potential impacts of the plan or project, inclusive of all activities and phases (e.g., preparation, construction, operation and, where relevant, decommissioning or reconditioning), and all must be assessed for every conservation objective for the site. The assessment must also identify the various types of impact, including direct and indirect effects, temporary or permanent effects, short- and long-term effects and cumulative effects (EC, 2021). In the case of *Margaritifera*, the type of information required to determine whether an effect is likely to be significant has been set out in section 3.4 of this guidance note. Furthermore, the Site-Specific Conservation Objectives for *Margaritifera* within the Site and the checklist of questions outlined in Table 8 of the CEN standard for *Margaritifera* (NSAI, 2017) which should be asked where short-term activities or long-term plans or projects are being assessed for potential damaging effects on a *Margaritifera* population, should be used to aid in the identification of likely significant effects. As noted in the OPR guidance document (2021), if the consideration of significance is becoming too

complex (i.e., with multiple factors involved) then this should be an indication that uncertainty exists, and that AA is required.

3.8.3 ... either individually or in combination with other plans or projects

Whereas some plans or projects may not individually give rise to significant effects on European Sites, the effects in combination with other plans or projects may be significant. The in-combination provision in Article 6(3) concerns other plans or projects that have been already completed, approved but not yet completed, or submitted for consent (EC, 2021).

As noted by the EC (2021), "*when a protected habitat or species in the site is already in an unfavourable condition or when critical thresholds of impacts for the habitats' or species' specific attributes are being exceeded (or if the site is subject to cumulative effects that will lead to either of these states), any additional plan or project which, either alone or in combination, adds further impacts to these levels is likely to have a significant effect on the Natura 2000 site*". This is particularly relevant in the case of the *Margaritifera*. The conservation status of *Margaritifera* is "bad and deteriorating" (NPWS, 2019) and water quality requirements for this species are often not met. For example, in relation to ecological quality objectives for *Margaritifera* habitat, an EQR of 0.90 or "high status" is required (S.I. No. 296/2009). However, a quick search of the EPA AA tool[17] reveals that this objective is often not being achieved in many *Margaritifera* catchments. As noted by Boon et al. (2018) aquatic ecosystems are often affected by multiple stressors simultaneously (e.g., siltation, hydromorphological degradation, nutrient enrichment), and the impact of these stressors will often result in synergistic effects on *Margaritifera*, as opposed to singular effects.

Table 3.3, taken directly from EC (2021), highlights the key steps for assessing cumulative effects on a European Site.

Table 3.3. The key steps for assessing cumulative effects on a European Site, extracted from EC (2021).

Steps in the assessment	Activity to be completed
Define geographic boundaries and the timeframe for assessment	Define boundaries for examining cumulative effects; note these will be different for different types of impact (e.g., effects upon water resources, noise) and may include remote (off-site) locations.
Identify all projects/plans that could act in combination	Identify all possible sources of effects from the plan or project under consideration, together with other sources in the existing environment and other possible effects from other proposed projects or plans; timing and phasing of projects or plans.
Impact identification	Identify the types of impact (e.g., noise, water resource reduction, chemical emissions) that can affect the structure and functions of the site vulnerable to change.
Pathway identification	Identify potential cumulative pathways[18] (e.g., via water, air; accumulation of effects in time or space). Examine site conditions to identify where vulnerable aspects of the structure and function of the site are at risk.
Prediction	Predict the magnitude/extent of identified likely cumulative effects
Assessment	Explain whether or not the potential cumulative impacts are likely to be significant, taking into account information collected during the 'assessing significance' step

Some key plans and project types that should be considered as part of the in-combination assessment include, but are not limited to:

[17] https://gis.epa.ie/EPAMaps/AAGeoTool

[18] A source-pathway-reception model may be useful for this task.

- Peat extraction damage and drainage
- Forestry projects (e.g., afforestation, deforestation, forestry roads etc.)
- Flood relief schemes
- Quarry operations
- Road developments
- Housing developments
- One-off housing
- Wastewater treatment[19]
- Windfarms
- County Development Plans
- Nitrates Action Plan
- Foodwise 2025
- Agricultural schemes and policies, including past drainage and damage *(GAP, ACRES, CAP)*

3.8.4 Implications of in-combination effects for changes to projects that were previously exempt or pre-dated the Habitat's Directive

As well as re-assessing permitted developments that may act in combination with a new project, some in-combination projects in operation in *Margaritifera* catchments pre-dated the Habitat's Directive and have never undergone Appropriate Assessment. If any changes, upgrades or ancillary projects in any way relating to historical projects are planned in a *Margaritifera* catchment, it is important to note that the full operation, system, plan or project in its entirety needs to be taken into the assessment. This brings into the assessment system projects that may never have been assessed before, even if they are not proposed to be changed as part of the new plans.

An example of this type of in-combination assessment is the upgrade of the Lough Talt Water Treatment Plant.

Communities in the region had been living with boil water notices since January 2019 following detection of cryptosporidium in the public water supply. The existing treatment was inadequate to address this risk. The Water Treatment Plant (WTP) is also on the Environmental Protection Agency's (EPA) Remedial Action List (RAL) due to unacceptable levels of trihalomethanes (THMs) in the water supply network.

During the assessment process for this upgrade an investigation into in-combination effects with the water supply abstraction was undertaken. These investigations included a risk assessment of the abstraction, which had not come under the planning process before, as it pre-dated the Habitat's Directive. It could not be concluded beyond reasonable doubt that the operation of the Lough Talt WTP upgrade would not have significant adverse effects on the conservation objectives of Lough Hoe Bog SAC, as it was operating as part of the abstraction element of the project.

An Article 6.4 application was made to continue the abstraction and upgrade the treatment plant on a temporary basis until a replacement abstraction could be put in place. This was approved, and the extensive upgrade works at the Lough Talt Water Treatment Plant subsequently enabled the boil water notice to be lifted.

[19] The EPA Sewage Treatment online GIS map (https://gis.epa.ie/EPAMaps/SewageTreatment) has a data layer which shows all urban areas where improvements to waste water discharges are required to protect freshwater pearl mussel. Further information about urban areas impacting on freshwater pearl mussel waters can be found in the EPA's Annual Urban Waste Water Report on the EPA website - www.epa.ie.

3.9 Content of Appropriate Assessment or NIS in View of the Site's Conservation Objectives'

3.9.1 Form of the assessment

If, following AA screening, the likelihood of significant effects cannot be excluded, stage 2 AA is required. The test for AA is whether the plan or project, either alone or in combination with other plans or projects, will affect the integrity of the European Site, considering possible mitigation measures.

In Ireland, an AA takes the form of a Natura Impact Statement (NIS), which must contain an assessment of all the aspects of the plan or project which can, either individually or in combination with other plans or projects, affect the conservation objectives of a European Site. The assessment must be undertaken in the light of the best scientific knowledge in the field, and based on objective scientific evidence and methods. The European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011) defines a NIS as "*a report comprising the scientific examination of a plan or project and the relevant European Site or European Sites, to identify and characterise any possible implications of the plan or project individually or in combination with other plans or projects in view of the conservation objectives of the site or sites, and any further information including, but not limited to, any plans, maps or drawings, scientific information or data required to enable the carrying out of an Appropriate Assessment*". The NIS must be submitted by the proponent of the plan or project for consideration by the competent authority, and should provide sufficient information to enable the competent authority to carry out the AA.

3.9.2 Content of the assessment

Notwithstanding the inherent variability in plans and projects, it is well established in case law that the AA (NIS) must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposed plan or project on a European site(s) (C-304/05)[20]. The AA must be undertaken in light of the conservation objectives of the European site, and therefore it is essential that the Site-Specific Conservations Objectives (SSCOs) for the Site are taken into account as part of the AA. The SSCOs aim to define, via a series of attributes (e.g., distribution) and targets (e.g., to maintain distribution at a given length of river) favourable conservation condition for a particular habitat or species at that Site. The conservation objectives for *Margaritifera* are largely the same across all SAC populations in Ireland and are to restore the favourable conservation condition of *Margaritifera* in each SAC.

The conservation objective of "restoring" favourable conservation condition is important, as implicit in this conservation objective is the need for all plans and project potentially affecting *Margaritifera* to demonstrate that any activities associated with them will either contribute towards the objective of restoration or at the very least will not prevent restoration being achieved.

As outlined by the NPWS[21], an AA must take account of the current unfavourable condition of *Margaritifera* populations and their habitat, particularly whether the plan or project could:

- Prolong the poor condition of the freshwater pearl mussel habitat
- Result in further deterioration in freshwater pearl mussel habitat condition
- Increase the area of freshwater pearl mussel habitat negatively affected

And in so doing:

- Prevent juvenile recruitment, owing to unsuitable juvenile habitat condition
- Cause stress to adult mussels resulting in reproductive failures
- Cause mortalities of adult mussels, impacting population size

[20] https://curia.europa.eu/juris/document/document.jsf?text=&docid=62977&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=491072

[21] https://www.npws.ie/research-projects/animal-species/invertebrates/freshwater-pearl-mussel/appropriate-assessment-and

- Result in an extended 'gap' in the population's age profile, impacting population size and future reproductive potential
- Increase the patchiness of mussel distribution, impacting future reproductive potential.

As noted previously, environmental objectives for *Margaritifera* have been established in law (the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations, S.I. 296 of 2009). The 2009 regulations set environmental quality objectives for the habitats of the listed *Margaritifera* SAC populations, particularly with regard to absence of algal and macrophyte cover (as these are indicators of excessive nutrient input), and no siltation of *Margaritifera* habitat. They also dictate conservation status assessments (such as juvenile recruitment levels) and these have been used as the basis for the SSCOs for *Margaritifera* SAC populations. The conservation objectives provide more detail in aspects of the mussel environment that are important to improvement is mussel recruitment levels, such as targets for redox potential (a proxy for interstitial oxygen), and a requirement to restore catchment hydrological function, as well as riparian seepages that provide juvenile food.

As noted previously in this document, *Margaritifera* is extremely sensitive to perturbations in its environment. Populations can be subject to direct damage as well as indirect damage arising from a wide range of activities in areas outside of its immediate habitat. Undertaking AA for this species is therefore challenging and will often require detailed scientific studies. These studies are not necessarily of the population itself (indeed, where detailed up-to-date information on a population exists, it may not be necessary to undertake additional dedicated studies of the population due to the potential risk of disturbance arising from survey work) but may include geomorphological, hydrological, hydrogeological and morphological studies, for example. The type of supporting studies required to support the AA will vary on a case-by-case basis depending on the nature and location of the project or plan and the potential impacts associated with it (although it is important to bear in mind that in some instances, certain impacts may not become apparent until detailed survey work has been undertaken – e.g., potential hydrological impacts). Restoration of a near-natural hydrological regime is necessary for the achievement of favourable conservation status for most freshwater pearl mussel populations, and therefore understanding how a plan or project will affect the hydrological regime of the watercourse will more than likely be an essential part of any AA.

Once again, the reader's attention is drawn to the checklist of questions outlined in Table 8 of the CEN standard for *Margaritifera* (NSAI, 2017). This checklist can aid in the identification of lacunae in the scientific assessment undertaken as part of the AA. Furthermore, sections 4.3 to 4.5 of this document highlight the essential information required to undertake an AA. Table 3.4 outlines the range of studies that might be required to support AA of a plan or project in a *Margaritifera* SAC.

The layout of assessment reports that will be transferred for consideration by a competent authority for the purpose of Appropriate Assessment should provide a clear link between all studies and justifications with every one of the targets listed under the Conservation Objectives for the relevant population(s).

Table 3.4. Studies which may be required to support AA of a plan or project in a *Margaritifera* SAC.

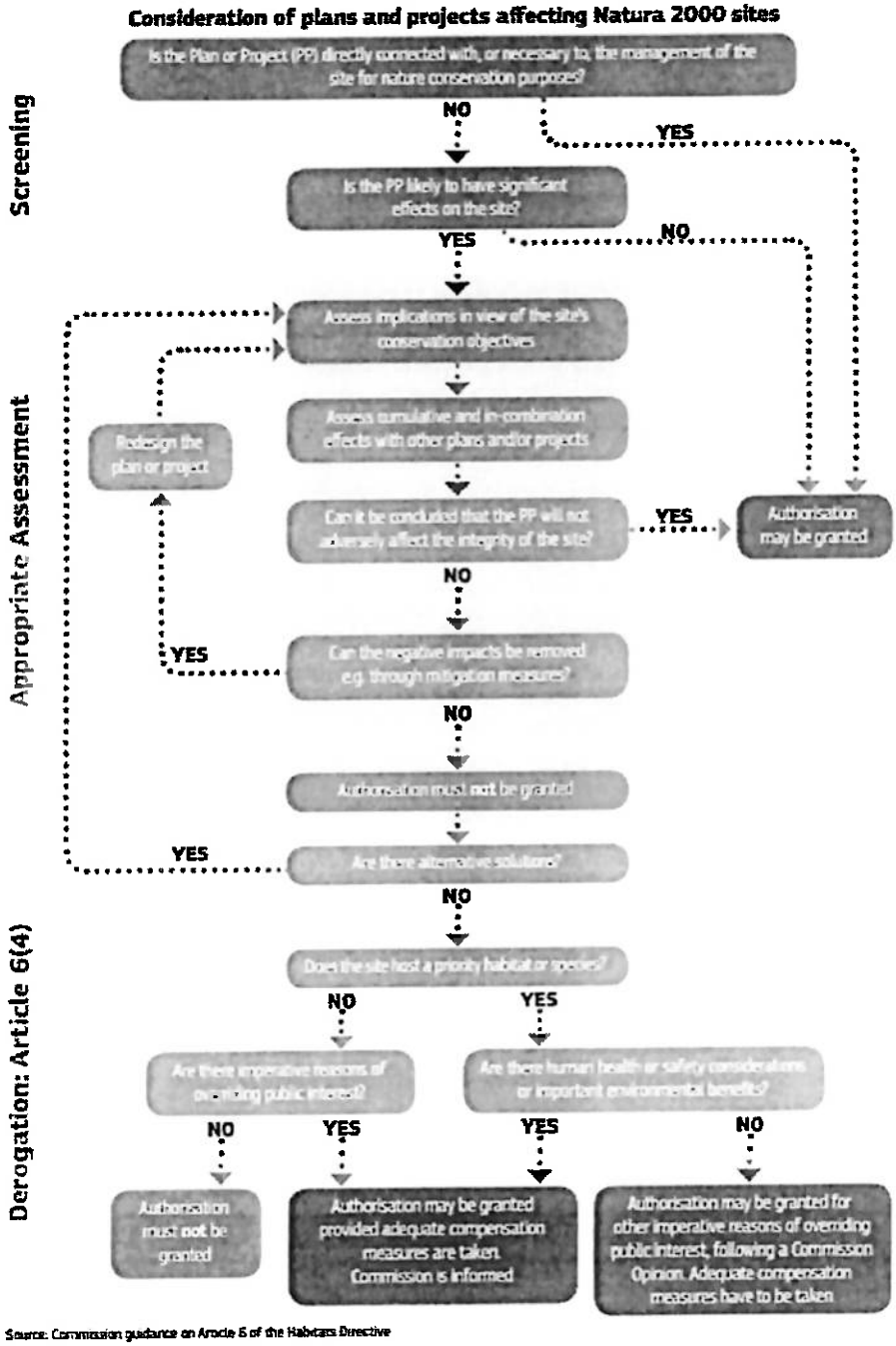
Study	Examples of why this study might it be required	How can it be undertaken?
Fluvial Geomorphological Study	To gain an understanding of baseline hydrological regime of a river, and how a plan or project might affect it. To identify hydrological pathways to the SAC during the lifetime of a plan or project. In instances where riverbank or instream works are proposed, it may be necessary to undertake dedicated fluvial geomorphology investigations to establish the baseline and predict how a plan or project will affect sediment transport and other geomorphic processes within the river. To gain an understanding of the baseline physical habitat condition within the river (e.g., identification of various river habitats, instream structures, evidence of bank erosion, evidence of nutrient enrichment, evidence of	Hydrological modelling Sediment transport modelling Fluvial audit River Hydromorphological Assessment Technique (RHAT)

Study	Examples of why this study might it be required	How can it be undertaken?
	siltation) and to understand how the plan or project might affect it.	
Hydrogeological Study	To gain an understanding of the hydrogeological context of a plan or project and how the plan or project might affect the baseline hydrogeology. To identify hydrogeological pathways to the SAC during the lifetime of a plan or project. Modelling may be used to assess the current hydrogeological impacts in a catchment, and remote sensing can be used to assist a model (Kuemmerlan et al., 2021).	Hydrogeological survey & monitoring
Hydrological modification study	Understanding hydrological structure and function of a study site with respect to its sub-catchment requires a detailed understanding of the hydrological processes within each sub-catchment. The observed degree of hydrological modification is an indicator of hydrological structure and function. Areas where hydrology has been largely unmodified and will not be modified can be classified as low risk. Areas where the hydrology has been modified through drainage and/or land use change can be classified as medium risk or high risk depending on the level of modification.	Comparison with old maps, ecological studies of habitat condition
Habitat Survey	Habitat surveys are important to understand the extent and condition of riparian buffer zones, identify hydrological pathways to the river habitat in which *Margaritifera* occur (e.g., drainage ditches), establish baseline land use, identify wetland habitat which may carry out an important role in flow regulation and provide an essential food source for juvenile mussels.	Walkover habitat survey
Water Quality Monitoring	Water quality monitoring may be required to understand the baseline water quality in the receiving *Margaritifera* catchment and therefore how any changes arising from the project or plan might affect *Margaritifera*.	Turbidity monitoring, macroinvertebrate assessment, water chemistry monitoring, redox potential studies
Stage 1 & 2 *Margaritifera* survey	Establish presence/possible absence of *Margaritifera* in a river and if present, estimate the adult population size.	Stage 1 & 2 *Margaritifera* survey by licenced surveyor
Stage 3 *Margaritifera* survey	Establishment of whether or not there is recruitment to the mussel population in a river. Stress testing of adult mussels. Survey methodology is potentially very destructive of mussels. This type of survey is unlikely to be required as part of an AA for a plan or project.	Stage 3 *Margaritifera* survey by licenced surveyor
Stage 4 *Margaritifera* survey	Repeat monitoring of *Margaritifera* and their habitat (combining survey techniques used in Stages 2 and 3 with recording of water quality parameters and detailed river channel character data, at prescribed intervals in time and space). This type of survey is unlikely to be required as part of an AA for a plan or project.	Stage 4 *Margaritifera* survey by licenced surveyor

The potential impacts should be recorded and ideally quantified using parameters that make it possible to assess the scale and severity of the impact on the SSCO of the *Margaritifera* population. As noted previously

in this section, not only should the assessment consider impacts on the current status of *Margaritifera* in the SAC, but also changes or continuation of the status quo that could prevent the restoration of the population within the SAC.

Once the potential impacts of a plan or project have been identified, the AA must identify mitigation measures to avoid or reduce potential adverse effects. These measures must be practical and achievable. An assessment of residual impacts should also be included. If the assessment is negative, i.e., adverse effects on the integrity of a site cannot be excluded, even with the application of mitigation measures, then the project or plan may not proceed without continuing to stage 3 of the AA process: Alternative Solutions (Figure 3.1). The AA report should be sufficiently detailed to demonstrate how the final conclusion was reached, and on what scientific grounds.



Source: Commission guidance on Article 6 of the Habitats Directive

Figure 3.1. Consideration of plans and projects affecting European sites (EC, 2019).

3.10 Mitigation Measures

Mitigation measures are an essential element of the AA. If, during the AA process, adverse impacts on the integrity of a European Site have been identified, it may be possible to apply mitigation measures to avoid these impacts or reduce them to a level where they will no longer adversely affect the integrity of the Site. However, it is vital that mitigation measures are not confused with compensatory measures which are only considered under the Article 6(4) procedure (Figure 3.1).

As per the mitigation hierarchy, in the first instance, avoidance measures should be implemented where possible, followed by measures aimed at reducing the severity of impacts or eliminating them entirely. The

effectiveness of each mitigation measure must be assessed and monitoring of the measures is crucial to ensure their successful and timely implementation and to detect any unexpected impacts requiring additional measures (EC, 2021). Each measure must be described in detail, based on sound scientific evidence, and accompanied by an explanation of how it will eliminate or reduce the adverse impacts which have been identified (EC, 2019).

Details of the implementation of the mitigation measures should also be provided, which should include proof that they can perform the desired protection, detail when they will be implemented, who will implement them, and how their effectiveness will be monitored at the relevant stage of the project or plan. It may be necessary to outline safeguards or potential corrective measures should the primary mitigation measure fail, particularly where a species as sensitive as *Margaritifera* is at risk of adverse effects.

Further details on the various mitigation and monitoring measures required to protect *Margaritifera* from a project or plan, during both the construction and operational phases, is provided in section 6 below.

3.11 Alternative Solutions

If, following AA screening, the likelihood of significant effects cannot be excluded, stage 2 AA is required. However, as noted by the NPWS (2009), an alternative possible option at this stage is to recommence the screening process with a modified plan or project that removes or avoids elements that posed obvious risks.

Alternative solutions (stage 3 AA) must also be considered where, following AA (stage 2) a negative assessment is concluded (Figure 3.1). This stage explores alternative ways of implementing a project or plan that, where possible, avoids any adverse effects on the integrity of a European site. It must be objectively concluded that no less-damaging alternative solutions exist before examining whether the plan or project is necessary for imperative reasons of public interest (EC, 2021). Further detail on how to proceed where a negative assessment is concluded at stage 2 is provided in section 5 below.

3.11.1 Interaction with the Environmental Impact Assessment

Environmental Impact Assessment is a method of ensuring that the likely effects of new development on the environment are fully understood and taken into account before consent is given for the development to proceed. As such its purpose is to improve the quality of decision making by identifying potential environmental issues early in the project process. Consideration of alternatives is an essential element of the EIA process. Whereas AA is a statutorily separate process to EIA, it is typically a parallel process in practice and therefore the outcomes of the AA should feed into and inform EIA and vice versa. The biodiversity section of an EIAR should refer to the findings of the AA in the context of likely significant effects on the environment, as required by the EIA Directive (EPA, 2022). Where adverse effects are identified during the EIA process, it may be possible for these to be avoided or reduced during consideration of alternatives and the design process (EPA, 2022).

3.12 Decision-making

Competent national authorities are those authorised to consent to a plan or project (e.g., local authorities or An Bord Pleanála). Under Article 6(3) of the Habitats Directive, the competent authorities can only consent to a plan or project once it is certain that the plan or project will not adversely affect the integrity of a European Site. If there is any uncertainty regarding the absence of adverse effects on the integrity of a European Site arising as a result of the plan or project, the competent authority will have to refuse authorisation, unless the process allows for the consideration of alternative solutions or imperative reasons of overriding public interest (IROPI). Article 6(4) of the Habitats Directive does provide for circumstances where, in spite of a negative assessment of the implications for the European Site and in the absence of alternative solutions, a plan or project must nevertheless proceed for imperative reasons of overriding public interest (OPR, 2021).

A competent authority is assisted in its Appropriate Assessment by the relevant Natura Impact Statement and associated studies. An Appropriate Assessment process at this stage that relies on third party reports should check very carefully that all the justifications for a positive assessment are complete and correct for all of the Conservation Objectives for the relevant SAC population(s).

When a local authority makes a planning decision, the decision can be appealed within 4 weeks of the date of the local authority's decision. An Bord Pleanála will then either grant permission as before, grant permission with amended conditions, or refuse permission.

Following the Bord's decision, there is an 8 week period in which judicial review proceedings can be commenced in the High Court, which will ultimately rule on the legality of the planning permission.

It is important for the safe and smooth running of the planning system that information for assessments provided by developers, and the assessments made by the planning authorities should be absolutely thorough and checked to be correct. It must be noted that if there was shown to be a flaw in the planning assessment made, even if discovered after the period for judicial review has expired, there is an obligation to protect the site from damage under Article 6.2 (see e.g., CJEU Case C-399/14 (Grune Liga Sachsen)).

4 ASSESSING THE POTENTIAL IMPACTS OF PLANS OR PROJECTS IN CATCHMENTS WITH *MARGARITIFERA* WHOSE POPULATIONS ARE NOT DESIGNATED AS SACS

4.1 Where can Information on the *Margaritifera* Populations be Found

As described in section 1.3, three categories of *Margaritifera* catchment have been recognised, namely, catchments of SAC populations, catchments of other extant populations and catchments with previous records of *Margaritifera* but the current status is unknown. Although *Margaritifera* populations which occur outside of SACs are not protected under the Habitats Directive, they are protected under the Wildlife Act (as amended) and as such, detailed assessment of the potential impact of plans or projects on these populations, and indeed other potentially unknown populations of *Margaritifera* is required.

Information on the geographic distribution of *Margaritifera* is required, as a starting point, to undertake an assessment. In the first instance, reference should be made to the *Margaritifera* sensitive areas dataset which can be downloaded from the NPWS website (see Table 3.1). This dataset provides a GIS shapefile layer of the catchments of the known extant populations of *Margaritifera* in the Republic of Ireland. Furthermore, records of *Margaritifera* can be obtained from the National Biodiversity Data Centre (NBDC) "Biodiversity Maps". The records available on the NBDC are from a range of sources which include, at present, Ireland's BioBlitz, River Biologists' Database (EPA), the database of the Conchological Society of Britain and Ireland, the All-Ireland Non-Marine Molluscan Database, and General Biodiversity Records from Ireland. As the precise location of a *Margaritifera* population is considered sensitive information, the spatial reference is blurred to 10km resolution on the web page.

Information on *Margaritifera* populations outside of SACs can be requested from the NPWS via a sensitive biodiversity data request. The NPWS define sensitive biodiversity data as any data that the NPWS does not wish to make publicly available, such as the exact location of endangered species. External bodies may apply for access to these data, but are required not to make it generally available (e.g., in reports or maps).

As noted previously in this guidance document, it is also important to bear in mind that since new populations of the *Margaritifera* continue to be discovered, the *Margaritifera* sensitive areas map should not be taken as an exhaustive list of *Margaritifera* catchments. Therefore, when environmental assessment is required in relation to any activity, plan or project, it should include an assessment of the possible presence of *Margaritifera* in water bodies which were previously unsurveyed, or where the species has previously been unrecorded. This is particularly important in areas where suitable bedrock could provide favourable river habitat to support freshwater pearl mussels, or where *Margaritifera* records exist for nearby rivers.

4.2 What Gaps in Information Need to be Filled

Margaritifera is sensitive to a myriad of pressures including changes in hydrology and hydromorphology, nutrient enrichment and siltation, all of which may arise from developments or activities within a river catchment. Accordingly, conservation and protection of the species must occur at the catchment level. Impact assessment of plans or projects on *Margaritifera* must also be undertaken at the catchment level.

Key information gaps that need to be addressed as part of any assessment of the impact of a plan or project on *Margaritifera* include:

- Whether the plan or project is within a *Margaritifera* sensitive areas catchment
- If the plan/project is not within a *Margaritifera* sensitive areas catchment, are *Margaritifera* likely to be within the catchment, if the answer is yes to:
    - The geology of the catchment area is non-calcareous
    - The river is in a catchment with a known *Margaritifera* population in a different waterbody
    - The river is in a catchment adjacent to a catchment with a known *Margaritifera* population
- If *Margaritifera* are likely to be within the catchment, identification of the potential sources and pathways for impact on the *Margaritifera* population which should be informed by:

- Detailed information about the project or plan
- Hydrological and hydrogeological context of the project
- Technical information on the construction design and implementation of the construction phase
- Technical information on the operational stage of the plan or project.
- The checklist of questions outlined in Table 8 of the CEN standard for *Margaritifera* (NSAI, 2017) which should be asked where short-term activities or long-term plans or projects are being assessed for potential damaging effects on a *Margaritifera* population.

- Identification of the potential impacts of the project or plan on *Margaritifera* during both the construction and operational stages.
- Identification of whether evidence-based avoidance or mitigation measures can be implemented to reduce or eliminate any potential impacts of the project or plan on *Margaritifera*.
- Assessment of the effectiveness of proposed mitigation and avoidance measures.
- Identification and incorporation of monitoring requirements into mitigation measures.
- Identification of residual impacts.

4.3 Technical Information on the Operational Stage of the Project Needed to Make an Assessment

Some of the key issues and questions to be answered on the nature of the development during its operation are outlined in **section 3.5** with an explanation as to why they are important in the assessment of the potential impacts on *Magartifera* in SAC catchments. The same principals apply in non-SAC catchments with some of the key issues summarised below.

Does the proposed plan or project involve any abstractions from, or emissions to surface waters?

Any emissions to surface waters may be deleterious to sensitive *Margaritifera* populations downstream. This may result from an increase in sediment, or nutrient concentrations, the entry of other pollutants into waters, or changes to the flow regime downstream. Abstractions may alter seasonal flow patterns and wetted areas with impacts on *Margaritifera* reproduction and survival.

Does the proposed plan or project involve any potential changes to groundwater levels, abstractions from, or emissions to groundwaters, or continuation of legacy changes that are currently impacting the population?

Changes to or continuation of legacy use of inappropriate land cover, land use, groundwater composition and quantity may manifest in surface waters, possibly some distance from the groundwater abstraction or discharge site, and possibly in another surface water catchment.

Does the proposed plan or project need to consider emergency and non-scheduled contingencies?

It is essential that adequate consideration is given to unplanned events. In particular, stop-start weather thresholds to trigger management interventions or mitigation measures should be included, and provisions for on-site containment of any pollutants arising during such an event while preparing for their safe removal and treatment.

Does the proposed plan or project need to consider decommissioning of infrastructure or site rehabilitation?

Removal of old infrastructure as part of project or plan implementation, and eventual decommissioning of infrastructure provided by the project or plan, including any site rehabilitation, must be adequately assessed as part of the Habitats Directive assessment before consent is given to proceed.

4.4 Technical Information on Construction Design and Implementation Needed to Make an Assessment

Some of the key issues and questions to be answered on the nature of the development during its operation are outlined in **section 3.6** with an explanation as to why they are important in the assessment of the potential impacts on *Magartifera* in SAC catchments.

4.4.1 Construction

Does the plan or project entail in-stream works or structures?

In-stream works or structures are high risk activities in *Margaritifera* catchments. They may be associated with flow control, flood protection, water abstraction or amenity provision, and can profoundly alter the physical and chemical environment of the *Margaritifera*.

Does the plan or project entail or require new or upgraded bridges?

Appropriate bridge design, including adequate clear spans is essential to protect against acute and chronic impacts. Bridge construction works necessitated by damage, or bridge upgrade require careful planning and timing with extensive mitigation and robust management controls.

Does the plan or project entail removal of vegetation cover or land use change?

Removal of vegetation exposes soils to erosion, and alters the natural hydrology of sites. The removal of riparian vegetation can affect buffering of other land use pressures and alter the physical environment of the *Margaritifera* through light and temperature changes. Changes in land cover can lead to changes in the interception of rain and/or evapotranspiration rates that affect catchment hydrological function. Land use changes can give rise to impact of themselves, but can also allow pressures that previously had no pathway to *Margaritifera* SACs to be realised as impacts.

Does the plan or project entail new drainage or maintenance of existing drainage?

New or altered drainage poses a high risk to *Margaritifera* because it alters hydrology, sediment and nutrient movement. Existing drains may already be contributing to unfavourable *Margaritifera* conservation status. Alteration of drainage may provide pathways for other catchment pressures and allow them to be realised as an impact on *Margaritifera*. Existing drainage may need to be remediated as part of the conservation objective to "restore".

4.5 Relating General Guidance to Specific Guidance for Individual Population Catchments

SAC populations for *Margaritifera* differ in their level of size, distribution, juvenile recruitment function, distance from recovery / restoration and landscape drivers of *Margaritifera* habitat. More specific guidance on a sub-basin level for the different populations will help to determine how any plan or project may impair population restoration.

A prioritization process for *Margaritifera* populations has been published (Moorkens, 2010) and subsequently NPWS developed a national conservation strategy for the freshwater pearl mussel in 2011 that has the objective of ensuring the long-term survival of the species in Ireland, while maintaining its broad geographic range. The strategy sets out a prioritised approach to the implementation of measures necessary to conserve the species. There are 10 prioritized populations, the so called "Top 8" best SAC populations that encompass approximately 80% of the Irish population (the Blackwater (Kerry), Bundorragha, Caragh, Cummeragh, Dawros, Glaskeelan, Owenriff, Ownagappul), and in addition the Derreen and Nore populations to include these very unique genetic resources (see Quick Access 2 at the start of this document).

For the prioritized populations, restoration measures and conservation plans or projects are particularly important and other plans or projects should identify their ability to contribute significantly to the very urgent restoration timetable needed for this endangered species.

5 A NEGATIVE ASSESSMENT AND ARTICLE 6(4)

5.1 Background

Article 6(4) of the EU Habitat's Directive allows for exceptions to the general rule of Article 6(3) – i.e., the Directive provides for limited circumstances where, in spite of a negative assessment of the implications for a European site and in the absence of alternative solutions, a plan or project must nevertheless proceed for imperative reasons of overriding public interest. This is referred to as "IROPI", and remains rare in Ireland (OPR, 2021). It should be noted that the competent authorities have the choice of either refusing or granting permission for a plan or project under Article 6(4). The text of Article 6(4) is as follows:

"If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission to other imperative reasons of overriding public interest."

Before planning permission under Article 6(4) can be granted, a number of key conditions and requirements must first be met and documented, these are as follows (EC, 2019):

- the "alternative solution" put forward for approval is the least damaging for habitats, species and for the integrity of the European site(s), regardless of economic considerations, and no other feasible alternative exists that would not adversely affect the integrity of the site(s);
- there are imperative reasons of overriding public interest, including those of a social or economic nature;
- all compensatory measures necessary to ensure that the overall coherence of the Natura 2000 network is protected are taken.

5.2 Re-examining Alternative Solutions

The first requirement of the Article 6(4) derogation procedure is to examine whether there are alternative solutions to the plan or project that could avoid adverse impacts on the integrity of European site(s) concerned. As noted by EC (2019), when negative effects on the integrity of a European site have been identified, the thorough revision and/or abandonment of a proposed plan or project should be considered. Therefore, the competent authorities must analyse and demonstrate the need of the plan or project concerned, taking into consideration the 'zero' option/'do nothing' scenario at this stage also (EC, 2019). However, it is imperative that the absence of a less-damaging alternative solution is objectively concluded, and that each alternative is put forward and assessed as a detailed proposal. This stage becomes critical if it appears that derogation procedures may need to be pursued (NPWS, 2009).

The competent national authorities are responsible for assessing the relative impact of alternative solutions on the European site(s) concerned. The assessment of various alternative solutions must be based on comparable scientific criteria. To this end, the comparative assessment should consider the habitats and species for which the site is designated, the site's integrity and its importance in the overall coherence of the Natura 2000 network (EC, 2022). If there are alternative solutions to achieve the goals of the plan or project, authorisation cannot be granted under Article 6(4), rather the alternative solution must be assessed as part of Article 6(3) as alternatives will require appropriate assessment in order to proceed (see **Figure 3.1** above).

The following list, extracted from EC (2019), outlines examples of potential alternative solutions for a plan or project. The alternatives may consist of different:

- ways to achieve the objectives of the proposed development;
- locations that may be available for the development having regard to protected habitats and species, for example, by defining different land transportation corridors in master plans for roads and motorways or different housing development zones;

- scale and size of the development;
- design solutions for the development;
- techniques, methods of construction or operational methods for the implementation of the development;
- timetable of the various activities and tasks at each of the implementation stages, including during construction, operation, maintenance and, if applicable, decommissioning or reconditioning.

Furthermore, due consideration should also be given to nature-based solutions (e.g., for flood relief), as these measures can often be equally viable and less detrimental to European sites (EC, 2019). As noted previously, the 'do-nothing' scenario should also be considered.

5.3 Examining Imperative Reasons of Overriding Public Interest

Where no viable alternative solutions with reduced adverse effects on the integrity of a European site(s) exist, the competent national authorities must consider whether the plan or project can be authorised for imperative reasons of overriding public interest. However, compensatory measures to ensure that the overall coherence of the Natura 2000 network is protected must be implemented in this instance, and the European Commission must be informed.

As noted by EC (2021), the concept of 'imperative reasons of overriding public interest' is not defined in the Directive. However, "*human health*", "*public safety*" and "*beneficial consequences of primary importance for the environment*" are mentioned as examples of such reasons in the second subparagraph of Article 6(4). In relation to other imperative reasons of overriding public interest of a "*social*" or "*economic nature*" (first subparagraph of Article 6(4)), the wording implies that only public interests, irrespective of whether they are promoted either by public or private bodies, can be balanced against the conservation goals of the Habitats Directive (EC, 2021). This has been confirmed through caselaw. Case C-182/10 ruled that "*An interest capable of justifying, within the meaning of Article 6(4) of the Habitats Directive, the implementation of a plan or project must be both 'public' and 'overriding', which means that it must be of such an importance that it can be weighed up against that directive's objective of the conservation of natural habitats and wild fauna and flora*"[22].

The competent national authorities are responsible for weighing up the imperative reasons of overriding public interest of a plan or project against the objective of conserving natural habitats and wild fauna and flora, and approval can only be granted where the imperative reasons for the plan or project outweigh its impact on the conservation objectives of European sites (EC, 2021).

The first project in Ireland to gain planning permission through Article 6(4) of the Habitats Directive was the upgrade of the existing Water Treatment Plant at Lough Talt, Co Sligo, granted in 2019[23]. The NIS and subsequent AA undertaken for the project could not conclude beyond reasonable scientific doubt that the operation of the Water Treatment Plant (namely the sustained abstraction from Lough Talt) would not have significant adverse effects on the conservation objectives of Lough Hoe SAC. Although the planning application included the proposal to remove the abstraction from the lake, this could not be done instantaneously. It was concluded that continued abstraction from Lough Talt until a new water source was commenced and the Lough Talt source ceased, an essential part of the project, would cause delays in progress towards achieving the conservation objectives of the SAC for Geyer's Whorl Snail *Vertigo geyeri*, a qualifying interest species. To avoid impacts on Geyer's Whorl Snail, abstraction associated with the project would have to be reduced by approximately 50% during a significant portion of the year (95 days), which was found inadequate to supply the existing population requiring a supplementary water supply. The competent authority (in this case Sligo County Council) concluded that consent for the project during the period that the abstraction was still active should be granted for imperative reasons of overriding public interest to address the ongoing contamination and public health risk. The consent included expensive and extensive compensatory measures, including the ongoing irrigation of the *Vertigo* habitat, as well as a reintroduction project for the snail, and three research studentships.

[22] https://curia.europa.eu/juris/document/document.jsf?text=&docid=119510&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=1798633

[23] https://www.eplanning.ie/SligoCC/AppFileRefDetails/18210/0

A planning application to extend the port was lodged with An Bord Pleanála in January 2014, under the Strategic Infrastructure Act, using IROPI (Imperative Reasons of Overriding Public Interest). This project has not yet been permitted.

The only known IROPI case involving the freshwater pearl mussel was for the continuation of drinking water abstraction from Ennerdale Lake in Cumbria, again a temporary continuation, until the water abstraction could be switched to another source 10 years later (United Utilities, 2019). The compensatory measures for the 10 year remaining abstraction included 13 practical projects, including the purchase of much of the catchment land, and 8 research projects aimed at ensuring a much higher quality of river habitat for when the abstraction ceased. The entire project, including the changes in infrastructure and the compensatory measures amounted to approximately £350M, and the abstraction ceased in March 2023.

5.4 Suitable Compensatory Measures

5.4.1 Content of compensatory measures

If it has been concluded that no alternative solutions less harmful to European sites exist, and that imperative reasons of overriding public interest are justified, as per Article 6(4), "*compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected*" must be taken. The Habitats Directive does not define "*compensatory measures*". However, the EC (2021) defines "compensatory measures" as follows:

"*The compensatory measures constitute measures specific to a plan or project, additional to the normal duties stemming from the Birds and Habitats Directives. These measures aim to offset precisely the negative impact of a plan or project on the species or habitats concerned. They constitute the 'last resort' and are used only when the other safeguards provided for by the Directive are exhausted and the decision has been taken to consider a plan/project as nonetheless having a negative impact on the integrity of a Natura 2000 site or when such an impact cannot be excluded.*

Compensation should refer to the Natura 2000 site's conservation objectives and to the habitats and species negatively affected in comparable proportions in terms of quality, quantity, functions and status. At the same time, the role played by the site concerned in relation to the biogeographical distribution has to be replaced adequately."

It is vital that mitigation measures are not confused with compensatory measures which are only considered under the Article 6(4) procedure. The EC (2019) outlines the following distinction between "compensatory measures" and "mitigation measures":

- mitigation measures in the broader sense, are those measures that aim to minimise, or even eliminate, the negative impacts likely to arise from the implementation of a plan or project so that the site's integrity is not adversely affected. These measures are considered in the context of Article 6(3) and are an integral part of the specifications of a plan or project or conditional to its authorisation;
- compensatory measures are independent of the project (including any associated mitigation measures). They are intended to offset the residual negative effects of the plan or project so that the overall ecological coherence of the Natura 2000 network is maintained. They can only be considered in the context of Article 6(4).

This has been established in case law. For example, Briels and Others versus the Minister van Infrastructuur en Milieu (C-521/12) addressed whether the development of new *Molinia* meadows on a site could not be taken into account in the determination of whether the site's integrity was affected. The claimants submitted that such a measure cannot be categorised as a 'mitigating measure'. The court ruled "*Article 6(3) of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site of Community importance, which has negative implications for a type of natural habitat present thereon and which provides for the creation of an area of equal or greater size of the same natural habitat type within the same site, has an effect on the integrity of that site. Such measures can be categorised as 'compensatory measures' within the meaning of Article 6(4) only if the conditions laid down therein are satisfied.*".

The EC (2021) explicitly outline what *cannot* be considered compensation measures. These include:

- the implementation of a management plan for the site;

- measures for improving the conservation status of a habitat type on a site that are already planned irrespective of the plan/project; or
- the designation as special area of conservation of an area already identified as being of Community importance.

Compensatory measures should be additional to the actions that are normal practice under the Habitats and Birds Directives or obligations laid down in EU law (European Commission, 2019). These include, among other things:

- habitat improvement in existing sites: improving the remaining habitat on the site concerned or restoring the habitat on another Natura 2000 site, in proportion to the loss due to the plan or project;
- habitat re-creation: creating a habitat on a new or enlarged site, to be incorporated into Natura 2000; or
- in some circumstances, proposing a new site of sufficient quality under the Habitats or Birds Directive and establishing/implementing conservation measures for this new site;
- species re-introduction, recovery and reinforcement, including reinforcement of prey species.

Importantly, compensatory measures must be practical, implementable, likely to succeed, proportionate, enforceable and adequately monitored. The measures must be based on sound knowledge of restoration ecology. The key elements for effective compensatory measures, as outlined in European Commission (2021) are set out in Table 5.1. A summary checklist of key issues to consider when designing compensatory measures as outlined in EC (2021) is set out in Table 5.2.

Table 5.1. Key elements for effective compensatory measures, extracted from EC (2021)

Location	**Must make it possible to maintain the overall coherence of the Natura 2000 network.** Should host – or be able to develop – the specific features, structure and functions required for compensation according to the results of the appropriate assessment. Must give proper consideration to qualitative ecological aspects such as the uniqueness of the features that will be impaired. Must be determined through careful analysis of local ecological conditions so that compensation is both feasible and as close as possible to the area affected by the plan or project. Must be within the same biogeographical region (for sites designated under the Habitats Directive) or within the same range, migration route or wintering area for bird species (i.e. sites designated under the Birds Directive) in the Member State concerned
Extent	Is determined by: • the extent of the plan or project's negative effects on the key features and ecological processes, which undermine the integrity of the Natura 2000 site; • scientific evidence of the measures' capacity to achieve the expected results for maintaining the overall coherence of the Natura 2000 network. Is best set on a case-by-case basis, according to the information generated in the appropriate assessment under Article 6(3). Is initially set with the aim of outweighing the worst-case scenarios of likely adverse effects. Is ascertained by monitoring and reporting on ecological functionality outcomes
Timing	Must ensure the continuity of the ecological processes essential for maintaining the structure and functions that contribute to the overall coherence of the Natura 2000 network.

Considers the coordination required between implementing the plan or project and implementing the compensatory measures

Is determined by the time required for habitats to develop and/or for species populations to recover or establish in a given area.

Must include legal safeguards required for long-term implementation and the protection, monitoring and maintenance of the sites to be secured before impacts on habitats and/or species occur.

May require the application of specific measures to outweigh interim losses that would occur until the conservation objectives are met

Requires the establishment of robust and complete monitoring programmes capable of assessing the success of compensation measures

Table 5.2. Summary checklist of key issues to consider when designing compensatory measures, extracted from EC (2021).

Action Line	Description	Elements to include
Technical	**Technical plan** The activities to be undertaken with an indication of their relevance according to: – the original site's conservation objectives; and – their relationship to the maintenance of the overall coherence of the Natura 2000 network.	Objectives and target values aligned to the site's conservation objectives
		Description of the compensatory measures proposed
		Demonstration of the technical feasibility of the measures in relation to their conservation objectives – ecological functionality
		Scientifically robust explanation of effectiveness of the activities in compensating the negative effects of the plan or project
		Prioritisation of activities according to the nature conservation aims – timetable aligned to nature conservation objectives
		Monitoring outline – per activity and overall
Financial	**Financial plan** The economic cost of implementing the programme of compensatory measures	Budget breakdown by cost category
		Budget breakdown by implementation timetable
		Demonstration of the financial feasibility of the measures according to the timing required and schedule for approval of the funds
Legal and administrative	**Safeguards for nature conservation**	Feasibility analysis of management rights: per type of activity and per suitable location (purchase, lease, stewardship, etc.)
		Demonstration of the legal and/or financial feasibility of the measures according to the timing required
		Identification of requirements for communication to the public
Coordination and cooperation – public authorities	**Roles and responsibilities in implementation and reporting**	Consultation, coordination and cooperation needs aligned to the timetable: agreement and approval of the compensatory programme by the Natura 2000 authorities, assessment authorities and the developer
		Monitoring plan based on progress indicators according to the conservation objectives, with reporting schedule and prospective links to existing assessment and monitoring obligations

Particular care and caution must be exercised where rare habitats or species, or habitats that require a long period of time to provide the same ecological functionality, will be negatively affected by a plan or project within a European site.

It must be noted that this guidance document provides a broad overview of the concept of compensatory measures. The EC (2019) document "*Management Natura 2000 sites – The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*" and the EC (2021) document "*Assessment of plans and projects in relation to Natura 2000 sites – Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*", referenced throughout this section, provide very detailed and comprehensive information on the identification, assessment, and adoption of compensatory measures. The detailed information provided in the aforementioned documents is not repeated here, and it is recommended that the EC guidance is given due consideration.

5.4.2 'Overall coherence' of the Natura 2000 network

As noted in chapter 1, SACs designated under the Habitats Directive, together with SPAs designated under the Birds Directive comprise the Natura 2000 network. As well as appearing in Article 6(4) of the Habitats Directive, the concept of 'coherent' networks is also introduced in Article 3 and Article 10. According to Article 3 (1):

"*A coherent European ecological network of special areas of conservation shall be set up under the title Natura 2000. This network, composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.*

The Natura 2000 network shall include the special protection areas classified by the Member States pursuant to Directive 79/409/EEC."

Measures to improve the coherence of Natura 2000 outlined in Article 3(3) of the Directive include "*maintaining, and where appropriate developing, features of the landscape which are of major importance for wild fauna and flora, as referred to in Article 10*". Article 10 of the Directive describes these "*features*" as "*those which, by virtue of their linear and continuous structure (such as rivers with their banks or the traditional systems for marking field boundaries) or their function as stepping stones (such as ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species.*"

Taking the above into consideration, protecting the coherence of the Natura 2000 network, as required in Article 6(4), could be interpreted as meaning the long-term protection of the overall geographic spread, structure, functioning and connectivity of habitats and species and the ecological communities of which they are part, for which sites within the Natura 2000 network are designated, to ensure the long-term viability and ecological functioning of them.

The importance of a European site to the coherence of the Natura 2000 network depends on the site's conservation objectives, on the number and status of the habitats and species for which it has been designated, and on its role in securing an adequate geographical distribution in relation to the range of the habitats and species concerned (EC, 2019).

5.4.3 Communication to the Commission of the compensatory measures

As stated in Article 6(4) of the Habitats Directive, each Member State must "*inform the Commission of the compensatory measures adopted*".

A standard form for supplying information to the European Commission regarding compensatory measures is available on the EC website[24]. According to this form, the information should:

- provide detail on the plan or project, particularly those elements and actions with the potential for having impacts on a European site;
- outline an assessment of negative effects on European sites, focusing on the adverse effects expected on the habitats and species for which the site has been proposed for the Natura 2000 network. Potential in-combination effects and mitigation measures included in the plan or project should be highlighted;

[24] https://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

- identify, describe and evaluate possible alternative solutions, including the zero option, and justify the alternative chosen or reasons why the competent national authorities have concluded that there is an absence of alternative solutions;
- identify, describe and justify the reasons for carrying out the plan or project, in spite of its negative effects;
- identify and describe the compensatory measures. The following detail is sought in the form:
  - objectives, target features (habitats and species) and ecological processes/functions to be compensated (reasons, why these measures are suitable to compensate the negative effects);
  - extent of the compensatory measures (surface areas, population numbers);
  - identification and location of compensation areas (including maps);
  - former status and conditions in the compensation areas (existing habitats and their status, type of land, existing land uses, etc.) ;
  - expected results and explanation of how the proposed measures will compensate the adverse effects on the integrity of the site and will allow preserving the coherence of the Natura 2000 network;
  - time schedule for the implementation of the compensatory measures (including long-term implementation), indicating when the expected results will be achieved;
  - methods and techniques proposed for the implementation of the compensatory measures, evaluation of their feasibility and possible effectiveness;
  - costs and financing of the proposed compensatory measures;
  - responsibilities for implementation of compensatory measures;
  - monitoring of the compensatory measures, where envisaged (e.g. if there are uncertainties concerning the effectiveness of the measures), assessment of results and follow-up.

As noted by EC (2019), information on the compensatory measures should be submitted to the Commission before they are implemented and before the implementation of the plan or project (but after its authorisation). This approach allows the Commission to request additional information or to take actions should it consider that the legal requirements of the Habitats Directive have not been applied correctly. The NPWS should play an important role in this process.

5.4.4 IROPI in the context of *Margaritifera*

As noted by EC (2019), the requirement for viable compensatory measures is challenging, and it presents itself as even more challenging when in the context of the freshwater pearl mussel, where the species can only thrive in oligotrophic, non-intensive catchments with the appropriate geological and hydromorphological environment with temperature levels that support all aspects of the mussel life cycle. It is impossible to create a *Margaritifera* environment, and the loss of a population can have a negative effect on the European network of *Margaritifera* populations. The only possible options for a successful IROPI permission for *Margaritifera* populations would be the case of a temporary situation, such as that for Ennerdale Water, where the abstraction for drinking water was deemed to be unsustainable for the mussels, but following the ten years of further abstraction the river flows would be restored, and the compensatory measures undertaken in the meantime, such as terrestrial catchment purchase and pressure removal, would leave this population in a good status into the future. The important aspect of this case is that it was time limited with an ultimate restoration of the population status. There have been no cases of IROPI where permanent damage to a *Margaritifera* population would ensue.

6 MITIGATION MEASURES STANDARDS FOR *MARGARITIFERA*

6.1 Introduction

Activities that occur in catchments where *Margaritifera* is known to be present must be shown to be sustainable, i.e., that the activity will not have a significant negative impact on the species or its habitat, or on the restoration of the population. If the potential for impact exists then mitigation, as required by the Habitats Directive, is necessary. In relation to SAC catchments, it is essential to demonstrate that the activities will not cause a deterioration in the habitat or a disturbance to the species in the context of an appropriate assessment as required by Article 6.

Mitigation means the removal beyond reasonable scientific doubt of the risk of impact and the achievement, or potential to achieve, favourable conservation status.

The preferred sequence of mitigation measures is first to avoid impacts at source and then minimize pressures through measures that will reduce and abate possible impacts at source or on site. Measures to prevent impact can include siting activities in areas where there is no pathway to allow impact to occur, or eliminating the pressure at source, e.g. prevention of elevated suspended solids in *Margaritifera* habitat through strict control measures at source (silt fencing in terrestrial conditions). In this regard it is important to consider in-combination effects of all pressures. Where risk of impact cannot be adequately mitigated, alternatives must be considered, including locating the activity outside the *Margaritifera* SAC catchment or in areas where no potential for impact arises.

When considering proposed mitigation measures, the Habitats Directive assessment should assess their feasibility in terms of the resource requirements for their implementation, management, maintenance and monitoring. Only mitigation that is assured beyond reasonable scientific doubt to be effective in the particular circumstances in which it is to be deployed is acceptable. All proposed mitigation must be specified (including exact location and design, and all relevant environmental parameters) so that it can be assessed for effectiveness and other possible impacts. For example, excavation of sediment retention ponds or lagoons may create new risks of sediment release or changes to the flow regime. Mitigation should also consider contingencies for unforeseen or unscheduled events.

Mitigation must be based on a clear understanding of baseline environmental and the overall landscape conditions in the operational area, and in the vicinity of any downstream *Margaritifera* populations. Where the project includes preparatory site works or construction, the proposed mitigation must include detailed and robust management protocols and auditable records.

For other extant populations a suitable environmental assessment will be required to demonstrate that the species, which is protected under the Wildlife Act (1976 and amendments), is not impacted by sectoral activities or any proposed development and that environmental damage in the context of the Environmental Liability Directive (Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage) is not caused or likely to be caused.

In all instances mitigation measures must be appropriate to the potential risk associated with the activity.

For projects that by necessity overlap with catchments that support populations of the freshwater pearl mussel, the highest level of diligence is needed at all stages from planning applications through to project completion and indeed to the end of operation and decommission. In order to gain permission for a project a very detailed design, description of construction and operation, and means by which they can be undertaken safely will be needed, with evidence to demonstrate that the project operation will have no negative effects, and that construction mitigation measures can be demonstrated to be capable of removing any risk of harm. The proof of the functionality of mitigation measures should be based on well-established evidence of their value. With all of these safeguards in place, permission can be given, generally with the condition that all mitigation measures are undertaken as defined within the planning application. The mitigation measures should be supervised by an independent Ecological Clerk of Works, and the planning conditions usually require it. Thus theoretically, the project can be completed without harm.

6.2 Hierarchy of Mitigation

Mitigation should be considered in a hierarchy consisting of avoidance, reduction or minimisation rehabilitation/restoration, and compensation. Mitigation measures are an integral part of a plan or project and aim to prevent any significant negative impacts on European Sites. It should be noted that in the context of the Habitats Directive, compensation should not be considered as part of the mitigation strategy. Compensatory measures are independent of the plan or project: they are intended to compensate for the effects on a habitat/species affected negatively by the plan or project.

Managing Natura 200 Sites (European Commission, 2019) states that:

"Compensatory measures constitute measures specific to a project or plan, additional to the normal practices of implementation of the 'Nature' directives. They aim to offset the negative impact of a project and to provide compensation corresponding precisely to the negative effects on the species or habitat concerned. The compensatory measures constitute the 'last resort'. They are used only when the other safeguards provided for by the directive are ineffectual and the decision has been taken to consider, nevertheless, a project/plan having a negative effect on the Natura 2000 site."

Compensatory measures to offset negative implications of particular actions (such as creating new habitat to replace damaged habitat) are highly unlikely to be feasible or effective in the case of *Margaritifera*.

6.2.1 Avoidance

Measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity. In relation to the *Margaritifera*, avoidance is favoured. It may be achieved either through siting development in locations remote from any designated or extant *Margaritifera* populations with no discernible pathway for impact, or through the elimination of the pressure at source, e.g. containment of pollutants at source.

6.2.2 Minimisation

Measures taken to reduce the duration, intensity and / or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible. For *Margaritifera* mitigation through minimisation means reduction of pressures to the extent that no significant impact on *Margaritifera* conservation status materializes. In the context of the freshwater pearl mussel minimisation through reduction of duration of an impact is not feasible. The sensitivity of the pearl mussel means that significant impact occurs even when duration of the impact is reduced, e.g. a one-off sedimentation event can result in the death of all juvenile mussels through degradation of the river substrate and suffocation of all juveniles resident in the river gravels. It is essential to consider cumulative impacts when determining whether individual pressures have been sufficiently minimized to prevent significant impact.

6.2.3 Rehabilitation/restoration

Measures taken to rehabilitate degraded ecosystems or restore ecosystems following impacts that cannot be completely avoided and/ or minimised. While rehabilitation and restoration are key ambitions for all *Margaritifera* populations, rehabilitation or restoration measures with respect to damage during or necessary to projects have limited application in relation to *Margaritifera*. They should therefore be utilised when addressing legacy issues that have resulted in previous degradation of *Margaritifera* habitat, or where emergency or accidental damage has occurred.

Margaritifera captive breeding programmes have been trialled in Europe and Ireland under controlled conditions. Captive bred mussels have been used as an emergency measure to augment wild populations and to prevent extinction of local pearl mussel populations in many countries including Germany, Ireland, Czech Republic, Scotland, Northern Ireland, Wales, and England (Geist et al., 2023). Captive breeding however cannot provide a sustainable restoration measure unless it is preceded by measures in the catchment to improve *Margaritifera* habitat, juvenile mussel habitat in particular. This is fundamental to support a fully recruiting sustainable population as defined under the EU Habitat's Directive, and to secure the long-term survival of *Margaritifera*. Medium-scale studies have shown how difficult it is to scale up from experimental breeding programmes to useful population augmentation in numbers that will make a long-term difference (Schmidt & Vandré, 2010).

Where catchment management measures have resulted in improved oxygen levels in the riverbed substrate, a less intensive technique of bankside encystment can be utilised to increase the number of juvenile mussels in the river. This has been successfully undertaken in Germany (Altmueller & Dettmer, 2006), and has shown that release of encysted salmonids is pointless until catchment management conditions are appropriate for juvenile mussel survival. Captive breeding is only suitable when carried out in conjunction with catchment and habitat improvements and cannot provide a mitigation strategy in isolation.

Restoration of the in-stream habitat has been trialled in other European countries such as Germany, Sweden and Luxemburg. This has included the importation of clean gravels and the replacement of large boulders removed historically for flow conveyance purposes. Some additional work has also been carried out to wash gravels in situ. The implementation of these measures in *Margaritifera* habitat is extremely difficult and can result in further damage to the habitat and individual populations. Where such measures have been implemented in Europe, the population numbers have been very low and mussels have been removed from the river in advance of these potentially damaging restoration activities. Restoration or rehabilitation of *Margaritifera* habitat through such short-term physical intervention is not considered a sustainable mitigation strategy to achieve favourable *Margaritifera* conservation status. The focus should be on a long-term strategies to address the pressures in the catchment to prevent impact either through avoidance or minimisation, such as agricultural deintensification and forest to bog restoration, which results in multiple benefits, including for climate change (Hermans et al., 2019).

6.2.4 Compensation

Measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimised and / or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity. Compensation measures for freshwater pearl mussel are extremely difficult given the complicated life cycle of the species and the need for pristine water quality and habitat. To recreate these conditions in the natural environment is very difficult to achieve. In addition, captive breeding to establish new populations, whilst successful in a controlled environment, has yet to be proven in the natural environment particularly where the habitat has been created artificially. Compensation is not seen as a suitable mitigation strategy for the *Margaritifera* and the focus must be on the protection and rehabilitation of the existing habitat through catchment management.

6.3 Mitigation by avoidance

Mitigation or control measures will depend on appropriate implementation and local site conditions (including factors like slope, drainage, terrestrial habitat, landscape features and characteristics of the receiving environment). In all cases the statutory burden of proof lies with the project proponent, developer or operator of the development or activity to show conclusively beyond reasonable scientific doubt that the control measure, or combination of measures will mitigate any significant impact on the *Margaritifera* based on the conservation objectives and supporting water quality standards.

Avoidance is the most common, and most preferable approach, whilst the abatement or rehabilitation of impacts at the receptor is undesirable. Mitigation should consider the alternative of locating activities outside *Margaritifera* catchments, or in remote locations where pathways to *Margaritifera* populations and habitat do not exist, and impact is therefore not possible.

6.4 Mitigation Measure Strategy

For projects that by necessity overlap with catchments that support SAC populations of the freshwater pearl mussel, the highest level of diligence is needed at all stages from planning applications through to project completion and indeed to the end of operation and decommission. In order to gain permission for a project a very detailed design, description of construction and operation, and means by which they can be undertaken safely will be needed.

At the forefront of considerations should be the ability to demonstrate, with evidence, that the project operation will have no negative effects on the *Margaritifera* populations. In this regard the operational impacts across the lifetime of the project must be considered in the first instance and only when it has been established that potential operational impacts can be mitigated to ensure that the plan or project will not prevent or delay the *Margaritifera* population reaching favourable condition, where the objective is to restore conservation status, or will not present a risk of the loss of favourable condition, where the objective is to

maintain, should the question around whether the plan or project be constructed or decommissioned safely arise. The flow chart in Figure 6.1 outlines the approach that should be adopted when considering the measures required to mitigation potential impacts on *Margaritifera* populations.

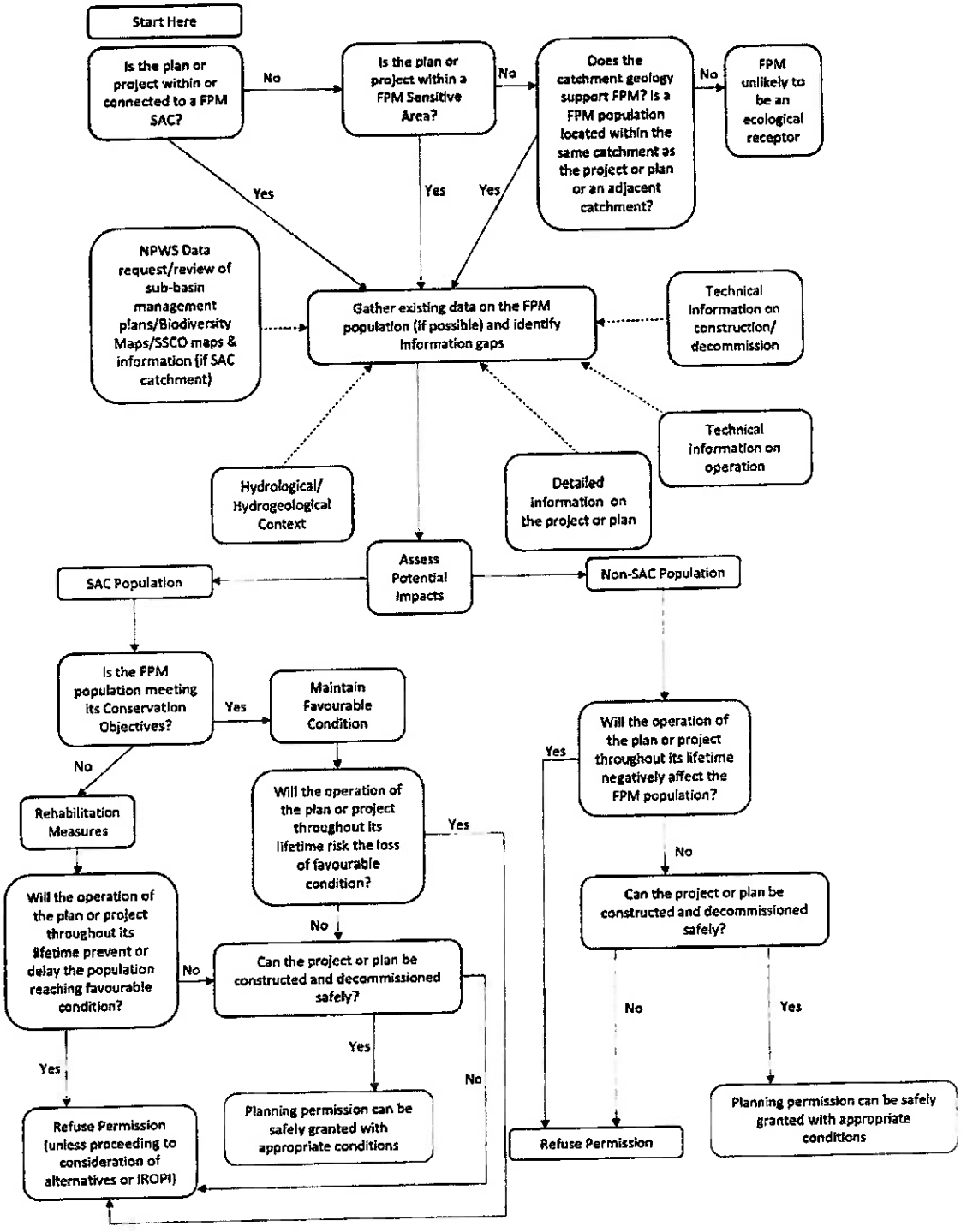


Figure 6.1: *Margaritifera* Impact Assessment Process

When considering the mitigation measures for *Margaritifera* in SAC catchments it is important to consider the conservation objectives that have been assigned for the species in the context of either the protect function to maintain *Margaritifera* populations that are in favourable conservation status or the restore function for those populations that are not achieving favourable condition.

Figure 6.2 provides an overview of the condition assessment for a *Magartifera* population in SAC catchments and whether the conservation objective is to restore or protect/maintain the favourable condition of the species.

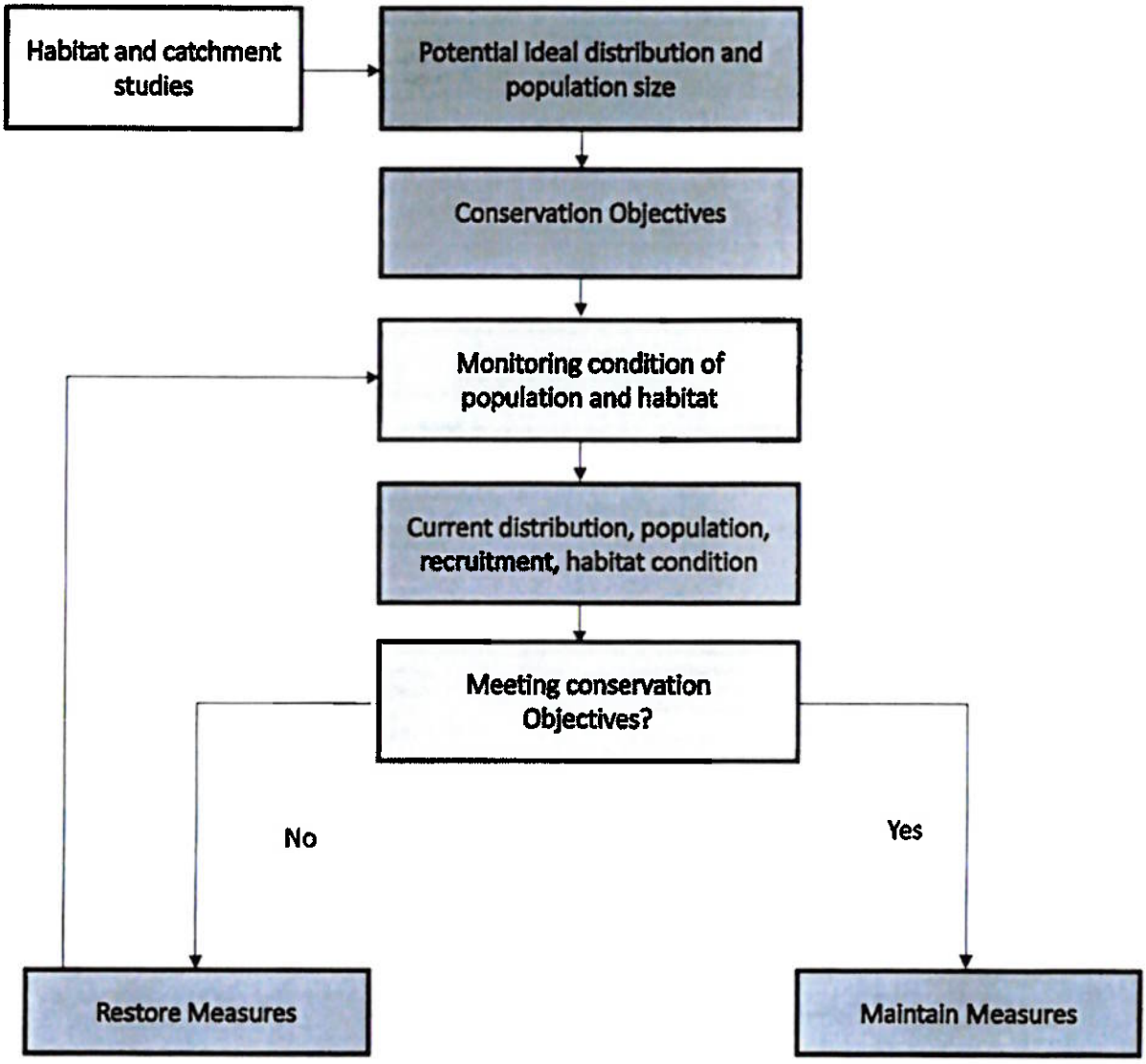


Figure 6.2: Conservation Objectives, Restore vs Maintain

Table 6.1 below summaries the 13 conservation objectives for all the SAC populations in Ireland. An indication of the requirements for the maintain and restore function is outlined for each conservation objective.

The onus is on the plan or project developer to demonstrate through their assessment, with suitable modelling where necessary, that the operation of the project will not adversely impact on favourable conservation status or prevent or delay the restoration of conservation status.

Table 6.1: Conservation objectives for SAC Margaritifera Populations

Conservation Objective	Target	Mitigation – Maintain Function	Mitigation – Restore Function
Distribution	Maintain Distribution as per Conservation Objectives suitable habitat length	Avoidance of direct impact on the *Margaritifera* population and ensure that the plan or project does not impact on the supporting habitat to ensure that extent of habitat is maintained so that the species is sufficiently widespread to maintain itself on a long-term basis	Plan or project should not prevent or delay the recovery of the population to favourable condition. At least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to further improvement in the supporting habitat to assist in the increasing the distribution extent where this has been reduced to ensure the species sufficiently widespread to maintain itself on a long-term basis.
Population Size	Population size should be at least the equivalent to the numbers for a sustainable population listed in the Conservation Objectives	Mitigation for the plan or project must ensure that there is no risk of direct mortality and that the habitat condition including the substratum quality, flow regime, water quality and fringing habitats is not compromised to an extent that there are unsustainable population losses above what would be considered to be natural fluctuations resulting in the loss of favourable condition.	Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to further improvements in the supporting habitat to assist in the re-establishment of a sustainable population size that is sufficiently abundant to maintain itself on a long-term basis.
Population Structure: Recruitment	At least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length	Young mussels are considered to be ≤ 65mm whilst juvenile mussels are ≤ 30 mm in length. Both cohorts are buried in the substratum and therefore rely on suitably clean stable substratum with the correct hydrological regime and good oxygen exchange with the water column. Impacts that can potentially affect the quality of the substratum, flow conditions and fringing habitat must be mitigated to ensure there is no unsustainable loss of these young and juvenile mussels ensuring that there is sufficient recruitment to allow the species to maintain itself on a long-term basis.	The plan or project should not prevent or delay the recovery of juvenile recruitment. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to further improvements in the supporting habitat to assist in the re-establishment of a juvenile recruitment to a level that is sufficient to maintain itself on a long-term basis.

Conservation Objective	Target	Mitigation – Maintain Function	Mitigation – Restore Function
Population Structure: adult mortality	No more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution	Mitigation for the plan or project must ensure that there is no risk of direct mortality and that the habitat condition including the substratum quality, flow regime, water quality and fringing habitats is not compromised to an extent that there are unsustainable population losses above what would be considered to be natural fluctuations resulting in the loss of favourable condition.	Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to further improvements in the supporting habitat to reduce adult mortality to natural levels so that the population has the ability to maintain itself on a long-term basis.
Suitable Habitat: Extent	Suitable habitat across the distribution in the Conservation Objectives any additional stretches necessary for salmonid spawning	As outlined in the Conservation Objectives Document, the habitat is a combination of the area of 1) habitat adult and juvenile mussels can occupy; 2) spawning and nursery habitats host fish can occupy. Fish nursery habitat typically overlaps with mussel habitat. Fish spawning habitat is generally adjacent to mussel habitat, but may lie upstream of the generalised mussel distribution. Only spawning areas that can regularly contribute juvenile fish to areas occupied by adult mussels should be considered in the assessment. Availability of mussel and fish habitat is determined by flow and substratum conditions. Mitigation must ensure that the plan or project does not impact on the habitat extent, including salmonid habitat, so that the species has sufficiently widespread suitable habitat to maintain itself on a long-term basis	Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to create conditions for habitat improvement where is has been established that the extent is not adequate for the population to maintain itself on a long-term basis.
Suitable Habitat: Condition	Restore condition of suitable habitat	Availability of mussel and fish habitat is determined by flow and substratum conditions. It is highly sensitive to hydromorphological changes, sedimentation and nutrient enrichment. Mitigation must ensure that the plan or project does not impact on the supporting habitat, including salmonid habitat, particularly from the pressures identified above, to ensure that condition of the habitat is not adversely affected so that the species is	Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve habitat condition where it is currently inadequate

Conservation Objective	Target	Mitigation – Maintain Function	Mitigation – Restore Function
		sufficiently widespread to maintain itself on a long-term basis	for the population to maintain itself on a long-term basis.
Water Quality: Macroinvertebrate and phytobenthos	Water quality: macroinvertebrates: Ecological Quality Ratio (EQR) greater than 0.90 (Q4-5, Q5); phytobenthos: EQR greater than 0.93	The EQR targets correspond to high ecological status for these two Water Framework Directive biological quality elements. They represent high water quality with very low nutrient concentrations, however it should be noted that . reaching these targets does not, however, guarantee achieving the targets for the other attributes for favourable conservation status e.g. hydromorphological supporting conditions. Mitigation must ensure that the plan or project does not impact on the water quality to ensure that condition of the habitat is not adversely affected so that there is sufficient habitat in favourable condition to allow species to maintain itself on a long-term basis	The Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve water quality where it is currently inadequate for the population to maintain itself on a long-term basis.
Substratum Quality: Filamentous Algae/Macrophytes	Substratum quality-filamentous algae: absent or trace (less than 5%); macrophytes: absent or trace (less than 5%)	The habitat must be almost totally free of filamentous algal growth and rooted macrophyte growth. Both block free exchange between the water column and the substrate and may also cause night time drops in oxygen at the water-sediment interface. In order to limit algal and macrophyte growth, the open water must be of high quality with very low nutrient concentrations therefore any plan or project must ensure that there is adequate mitigation to prevent increase in nutrient levels above those typically found in ultra-low oligotrophic waters.	The Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve substratum quality where it is currently inadequate and resulting in filamentous algae and macrophytes that are above the target for favourable conservation status.
Substratum Quality: Sediment	Substratum quality-stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment	The lack of fine material in the river bed substrate allows for free water exchange between the open river and the substrate's interstitial water. This ensures that oxygen levels within the substrate do not fall below those of the open water. The substrate must be free of inorganic silt, organic peat and detritus, as all of these can block oxygen exchange.	The Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve substratum quality through reducing erosion along pathways that lead to

Conservation Objective	Target	Mitigation – Maintain Function	Mitigation – Restore Function
			Margaritifera habitat and to improve the hydrological regime to improve the cleansing of the *Margaritifera* habitat of fine sediment.
Substratum Quality Oxygen availability	No more than 20% decline from water column to 5cm depth in substrate	The substrate must be free of inorganic silt, organic peat and detritus, as all of these can block oxygen exchange. Organic particles within the substrate further exacerbate the problem by consuming oxygen during the process of decomposition. Clean, coarse and stable substrate is essential for juvenile survival, as this species requires continuously high oxygen levels. In order to maintain favourable conservation status it is therefore necessary to ensure that a plan or project does not significantly impact on the oxygen availability through the colmation of stream bed interstitial spaces through the introduction of inorganic silt, organic peat and detritus that could lead to the deterioration in the favourable conservation status is achieved.	The Plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve oxygen availability where it is currently inadequate, i.e. to restore conditions to no more than 20% decline from water column to 5cm depth in substrate
Hydrological Regime: Flow variability	Presence of an appropriate hydrological regime	Maintaining natural flow variability in *Margaritifera* catchments is an essential requirement for a fully functioning population, including enough high flows to cleanse river-bed substrates. The most appropriate way of ensuring adequate flow in *Margaritifera* populations is to maintain a natural, abstraction-free regime in the sub-catchment influencing the population, and to manage the surrounding catchment in a manner that does not affect the natural flow regime. In order to maintain favourable conservation status, it is therefore necessary to ensure that a plan or project does not significantly impact on the natural flow regime, e.g., introduction of additional drainage that impacts on the natural flow conditions present when favourable conservation status is achieved.	To restore the habitat for the species, flow variability over the annual cycle must be such that: 1) high flows can wash fine sediments from the substratum; 2) high flows are not artificially increased so as to cause excessive scour of mussel habitat; 3) low flows do not exacerbate the deposition of fine sediment or growth of algae/macrophytes and 4) low flows do not cause stress to mussels in terms of exposure, water temperatures, food availability or aspects of the reproductive cycle Therefore, a plan or project must not prevent or delay the recovery of the hydrological regime to that which is supportive of a fully functioning population and demonstrate their contribution to the restoration of the hydrological regime through measures to mitigate the impacts of artificial drainage, and other unsuitable land use change.

Conservation Objective	Target	Mitigation – Maintain Function	Mitigation – Restore Function
Host Fish	Presence of sufficient juvenile salmonids to host glochidial larvae	Fish presence must be sufficient to carry the larval glochidial stage of the *Margaritifera* life cycle but not at higher densities and biomass that would be indicative of enriched conditions in *Margaritifera* rivers. In order to maintain favourable conservation status it is therefore necessary to ensure that a plan or project does not significantly impact on the juvenile salmonid density in the areas of *Margaritifera* habitat or upstream spawning areas to ensure favourable conservation status is maintained.	The presence of sufficient juvenile salmonids is essential to reach favourable conservation status. While the achievement of the habitat conditions described above are likely to also result in suitable habitat for salmonids, barriers to migration may exclude salmonids from previously occupied river stretches and therefore a proposed plan or project must consider these morphological pressures also and ensure that they do not prevent or delay the rehabilitation of the habitat where these pressures are present.
Fringing Habitat and condition	Ensure there is sufficient area and suitable condition of fringing habitats necessary to support the population	Semi-natural and natural riparian habitats, including those along lake fringes, even where they do not form part of a natural floodplain, are an integral part of the structure and functioning of river systems. Open wetlands, such as wet heath and blanket bog, are particularly critical to the hydrological regime of mussel rivers, as are rush-dominated wet grassland habitats. Fringing habitats assist in the settlement of fine suspended material, protect banks from erosion and contribute to nutrient cycling, as well as contributing to the aquatic food web (e.g., allochthonous matter from poor fens and flushes) and providing habitat (refuge and resources) for life stages of fish, birds and aquatic invertebrates. Equally, fringing habitats are dependent on rivers/lakes, particularly their water levels, and support wetland communities and species of conservation concern. Any mitigation must ensure that the plan or project does not impact on the supporting fringing habitat, and landuse changes that impact on the sensitive habitat outlined above should be avoided to ensure that condition of this habitat is not adversely affected so that the fringe habitat is sufficient to allow the species to maintain itself on a long-term basis.	Any plan or project should not prevent or delay the recovery of the population to favourable condition. Therefore, at least the same standard of mitigation will be required for as the maintain function. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to sustainable fringing habitat.

6.5 Operational Mitigation Measures and Emergency Actions

Providing specific details on the nature and type of mitigation measures required during the operational stage necessary to achieve the conservation objectives for individual *Margaritifera* populations is beyond the scope of this guidance. However, some of the key principals in mitigating the predominant pressures that impact on the different attributes of conservation status listed in Figure 6.1 are outlined below.

6.5.1 Flow Regime

Flow regime is critical to sustainable *Margaritifera* populations. It influences temperature and oxygen conditions, riverbed substrate and mussel stability, the sediment interstitial environment of juvenile mussels, and mediates feeding and respiration of both adult and juvenile mussels, and reproduction.

While flow regime, including discharge volume and velocities, is a dynamic feature, it fluctuates within normal seasonal and annual limits. Many factors can influence the regime and result in changes beyond the prevailing norm that provide conditions for sustainable *Margaritifera* populations.

Margaritifera is adapted to stable habitat that is kept clean through high water velocities, even at low flows with low fine sediment infiltration not habitat that is subject to regular fine sediment infiltration (Moorkens and Killeen, 2014).

Impacts can be mitigated by avoiding land use change or management activities that result in deviation from normal flows. Changes that include removal of natural ecosystems such as blanket bog or wetlands as part of plans or projects are unacceptable. Even without drainage, agricultural intensification or changed vegetation leading to increased interception, evapotranspiration, and drier soils, such as densely planted trees or other crops profoundly influence system function with respect to surface water retention and release to the river. Lack of water storage and drying of soils leads to impaired near-bed velocity in dry periods, fragility and erosion of soils and subsequent loss of carbon to dissolved organic carbon in the aquatic environment downstream.

Drainage can act cumulatively with vegetation change to cause more rapid run-off resulting in higher peak flows and destructive water velocities, leading to dramatic sediment erosion and nutrient loss during high rainfall periods. Water storage capacity is lowered in drained areas, resulting in lowered water velocities during dry periods. *Margaritifera* requires a minimum flow velocity to avoid impairment of the mussels and their habitat (Moorkens & Killeen, 2014). Where drainage is contributing to existing unfavourable conservation status, further new drainage or improvement of existing drains should be avoided. In the case of existing drainage systems, sediment and nutrient pressures may be abated through the use of end of drain buffers or systems of drainage water diffusion before discharge to rivers, but impairment of water storage may not be sufficient to reverse where drainage is maintained.

In the case of residential, commercial or industrial development, sustainable drainage solutions such as permeable surfaces to facilitate infiltration, are unlikely to be successful and storage solutions with controlled release via hydrobrake structure or similar at greenfield rates will not restore the hydrological function required for a sustainable *Margaritifera* habitat. A more holistic approach is required. Peatland soils are the most important for habitat restoration. In mineral soils the development of SuDs that incorporates habitat typical of natural riparian landuse in *Margaritifera* mineral habitat should be incorporated, e.g., wet grassland. The project proponent should ensure that adequate investigation, including hydrological or hydraulic modelling, is undertaken to demonstrate that the hydrological function of the development site is not impacted and where previously impaired is enhanced as part of the proposed plan or project to facilitate restoration of habitat where required.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.5.2 Sedimentation

Sediment release to aquatic systems and eventual deposition on *Margaritifera* habitat is a common source of impact and *Margaritifera* habitat degradation. Identification of the sensitive areas that are liable to sediment erosion should precede any on-site activities so that such areas may be avoided in the first instance during the plan preparation or project design.

Where activities must be undertaken during the operation of a development in these areas, measures must seek to prevent sediment mobilization through exclusion of agents of soil disturbance (heavy machinery, site traffic), or use of protective coverings such as mats or runners, and disturbance should be minimized in size and temporally, so that it can be undertaken only during dry conditions. Containment of any sediments at the source requires rigorous management, and mitigation measures must first seek to prevent sediment release to the aquatic zone where abatement becomes very difficult. Multiple barriers in sequence may be required to adequately reduce the impact at source.

In some circumstances sedimentation pressures may be abated by collection and treatment of contaminated waters. Sediment traps, or settlement lagoons from hard surfaces such as roads and car parks may provide some mitigation. Mechanical silt removal such as through "siltbusters" acting in parallel is also possible, but only where chemical coagulants are not used in combination with them. Heavy metals have long been known to be toxic to adult, juvenile and larval (glochidial) mussels (Wang et al., 2007; Markich, 2017; Khan et al., 2018). Coagulants from industrial plants and from sedimentation reduction processes used during construction changes the chemical and physical properties of water. However, with regard to the level of abatement required to safeguard *Margaritifera*, their management and performance is critical. They are frequently of inadequate design, inappropriately sited, and may be poorly maintained or managed. In such circumstances mitigation measures for one purpose can become further sources of impact to downstream *Margaritifera*.

Even when such systems are performing optimally it is extremely difficult for them to produce an effluent of sufficient quality to allow discharge to *Margaritifera* catchment waters. Collection for on-site / offsite treatment, or discharge outside the catchment boundary may be preferable.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.5.3 Nutrients

Margaritifera occurs generally in oligotrophic waters. Any eutrophication of those water can have adverse impacts, and may arise due to application of fertilizers or discharges of nutrient rich effluents. As a first measure mitigation should avoid any further additions of nutrients to catchment waters upstream of *Margaritifera* populations. This may require changes in land use or land management methods. It could also mean siting facilities or their outfalls in locations where they cannot impact *Margaritifera*.

Assessment of projects such as agricultural schemes should choose separate approaches for western peaty catchments, where restoration of natural habitats should be prioritized, and eastern mineral catchments, where more intensive food production can be balanced with habitat conservation. Whole farm nutrient management plans are essential in *Margaritifera* catchments, including very careful management of the farm buildings and yard.

Where nutrients are applied to, or derive from terrestrial ecosystems, it may be possible to reduce the pressure at source. Firstly, it must be demonstrated that soils are mineral rather than peaty in nature. The timing and conditions of fertilizer application are crucial in this regard, and careful attention must be paid to weather, topographic conditions and adequacy/effectiveness of buffer zones. Application should be based on established crop needs and occur at times when nutrient uptake is maximized.

Landscape features may help in abatement of impact on site. In mineral soils features such as vegetated buffer strips and riparian woodland can reduce nutrient export to the aquatic environment through curtailing discharge of enriched surface water, absorption and uptake of nutrients.

In the case of discharges to waters, elaborate on-site treatment of effluents, or off-site treatment and disposal may be required to adequately abate impacts on *Margaritifera* receiving waters. Consents, licences, or permits for any operational discharges must adequately consider the needs of the *Margaritifera* and include environmental quality objectives that are compatible with *Margaritifera* conservation requirements. Guide values for a range of parameters are set out in the Favourable Conservation Table – Informative Annex of the CEN Guidance. It is also essential that rigorous monitoring of such discharge consents is put in place to ensure compliance and prevent chronic or episodic impact on *Margaritifera*.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.5.4 Other Pollutants

Margaritifera is a species that is demanding of pristine water quality conditions, and is very sensitive to a range of pollutants. Toxic pollution can have very serious and long-term effects on *Margaritifera* which, being benthic suspension feeders, are exposed to pollutants in surface water, sediment, interstitial water and through ingestion of filtered particles with sorbed contaminants. Substances such as pesticides, heavy metals, persistent organic pollutants, polychlorinated biphenyls (PCBs) and other priority dangerous substances have all been shown to be toxic to bivalve mussels that are less sensitive than the freshwater pearl mussel. Given the sensitivity of the pearl mussel to these substances, it is difficult to derive precise quantitative thresholds for impact prevention. Therefore, in the absence of adequate effluent treatment methods, a precautionary approach should be used, and discharges that may contain these substances must be avoided in watercourses inhabited by *Margaritifera*.

Iron ochre is a significant toxicity threat and enters the water following drainage, particularly of peat habitats. Disturbance of peaty soils should be avoided by project design.

In the case of pesticides, or other toxic chemicals that may be used in *Margaritifera* catchments, the pressure impact must be reduced at source through avoidance of substance preparation, use or application in sensitive areas, or areas where loss to waters is possible. This could include treatment of trees in remote nurseries before planting, or movement of sheep to facilities outside catchment boundaries for dipping.

Impacts may be abated on site through strict adherence to protocols for safe storage, use and disposal of such chemicals.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.6 Construction Mitigation Measures

Once it has been established that the plan or project can be implemented without compromising conservation objectives of the *Margaritifera* population it is necessary to demonstrate beyond reasonable scientific doubt that the project or plan can be constructed and decommissioned safely.

A positive conclusion resulting in permission for a project may include mitigation measures, as the design and method of construction of a project may be critical to the removal of residual risk from a permitted project. A complete design, including construction methods and mitigation measures are required in advance of planning in order to avoid lacunae during the assessment process, following a European Court of Justice ruling:

"[The Appropriate Assessment] cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned".

Case C-258/11Sweetman v. An Bord Pleanála [2013] ECR I – 0000 (11 April 2013)

When a project has been granted permission under the strict rules above, there are usually many planning conditions to ensure that all the mitigation measures proposed are undertaken. Demonstration of compliance with the planning permission, sometimes following extended monitoring of the mitigation measures, and sometimes with ongoing licencing requirements during the operational stage completes the process.

Given the requirements of the *Margaritifera* for near-pristine conditions of flow velocities, oligotrophic waters demonstrating a lack of nutrient pollution and clean, silt-free interstitial environments in riverbed gravels, a sub-catchment for the habitat supporting such a flagship species is considered to be the most difficult location to undertake a construction project. For this reason, a protocol has been developed and implemented by Evelyn Moorkens Associates (EMA) to manage project construction to include all the mitigation measures conditioned, and to maintain a spreadsheet of all work items that can be used for compliance reporting purposes. This protocol is known as the Schedule of Works Operation Record (SOWOR) system.

6.6.1 The management of the project through the Schedule of Works Operation Record (SOWOR) system

The SOWOR method of undertaking project construction and operation was developed to provide a standard of excellence in practice, documentation and compliance that can achieve the aim of safe removal of construction risk, improvement of the knowledge base for future applications, and for construction companies to demonstrate that they are safe and reliable partners in good conservation practice.

The SOWOR is normally run by an independent Ecological Clerk of Works (ECoW), who is trained to implement the process. This independent monitor (or suite of people depending on the project size) needs to work closely with the developer's contract team and their environmental managers and expert advisors.

The contracting team with their Environmental Manager provide the numbered Method Statements. There is normally an Employer's Representative with environmental expertise to agree the final lines as transferred to the SOWOR. The commissioning team (employer / developer) cannot delegate all responsibility to the contractor, nor can the contractor put responsibility for good practice in the hands of the ECoW. It is important that the ECoW is somewhat removed from the contractor, and is ideally paid for and employed by the developer / employer who must comply with the consenting body conditions. In that way there is a strong interest in the compliance outcome.

6.6.2 Triggers for the SOWOR

Together with the ECoW, environmental triggers for safe undertaking of the high-risk work items, such as in-stream works or pouring of cement at a site near the river are agreed between the contractors, employer's representative along with any other experts or technical specialists needed for high risk aspects of the project.

While the responsibility for safe practice rests with the contractor in agreement with the developer / employer, the ECoW must have the power to stop any works where the SOWOR is in danger of demonstrating a failure to properly implement the planning conditions, i.e., where the agreed triggers have been activated. This way he/she can assist with the role of the contractor and employer in delivering compliance. The ECoW is responsible for monitoring and reporting compliance, not for delivering it.

6.6.3 Maintenance of the SOWOR

The SOWOR is run as a spreadsheet with 21 columns and the number of rows that constitute the number of work items in the construction project. There spreadsheet can be divided into 3 steps.

1. **Step 1: Detailed Method Statements are numbered into sequential work items. Each numbered work item forms a line in the SOWOR spreadsheet.**

The work items should be clear and understandable, and agreed between the construction contractors and the developer / employer, and understood and transferred to a spreadsheet by the ECoW.

An example of a transferred set of work items is given in Table 6.2.

2. **Step 2: Each numbered line has a risk value associated with it, leading to a hold point and proceed point that are usually linked to triggers such as rainfall levels, turbidity levels, weather forecasts and river flow levels.**

The risk values and triggers should be agreed between the construction contractors and the developer / employer, and understood and transferred to a spreadsheet by the ECoW. An experienced ECoW may assist with determining these values, but the responsibility rests with the developer / employer.

The triggers must be very clearly defined. Examples are given in Table 6.3.

Table 6.4 shows an example of commencement and abandonment triggers inserted into a SOWOR spreadsheet. Columns 1 and 2 are included, and the spreadsheet is shown for an example of each type of risk level in a work item.

3. **Step 3: Each line in the spreadsheet is filled as the tasks are completed, with any comments on problems, delays, damage, remediation.**

This is done by the ECoW with the assistance of the construction contractors and the developer / employer. At all times the SOWOR spreadsheet is available for all staff to view, but it is only managed and maintained by the ECoW.

By the end of the project construction there is a full record of the entire permitted process.

Table 6.5 shows a sample of Columns 15-21 of the SOWER spreadsheet.

Table 6.2: Example of transferred Work items (Columns 1-5)

1 Activity	2 Work item	3 Number of detailed Method Statements	4 Date planned for commencement	5 Expected Duration
1	Confirm the absence of freshwater mussels	MS01	30/4/23	1 day
2	Exclusion fencing with sediment control	MS02	01/05/23	3 days
3	Delivery of Site Compound units	MS02	04/05/23	1 day
4	Materials delivery	MS02	05/05/23	1 day
5	Temporary Fencing and Signage	MS02	05/05/23	1 day
6	Delivery of Silt Settlement Units	MS03	05/05/23	1 day
7	Set up of emergency sediment response	MS03	06/05/23	2 days
8	Excavation of pipe trench	MS04	08/05/23	3 days
9	Pipe laying	MS04	10/05/23	1 day
10	Backfill of pipe trench	MS04	11/05/23	3 days
11	Delivery of kiosk	MS05	14/05/23	1 day
12	Excavation of kiosk platform and shuttering	MS05	14/05/23	2 days
13	Concrete pour	MS05	17/05/23	1 day
14	Removal of temporary shuttering	MS05	25/05/23	1 day
15	Siltation checks	MS06	30/05/23	1 day
16	Removal of Silt settlement units	MS06	30/05/23	1 day
17	Removal of compound materials and signage	MS07	01/06/23	2 days
18	Silt fence check	MS08	30/06/23 30/07/23	1 day 1 day
19	Silt fence and temporary fence removal	MS08	01/08/23	2 days

Table 6.3: Examples of triggers used in a SOWOR

Trigger	Definition	In advance of work items	During work items	Trigger 1 Very high risk	Trigger 2 Intermediate Risk	Trigger 3 Low risk
1 Weather Forecast	Weather forecast information for rain, wind and storm will be obtained from at least two reliable sources namely Met Eireann and AccuWeather.com. The most pessimistic forecast will be used initially until a picture of which forecast is the more accurate for the area is established.	Longer term 5 and 10 day forecasts for work activity planning	Shorter term 12hr, 24hr and 3-day forecasts during construction (rainfall forecasts updated every 3hours.)	1 hour rainfall > 2mm 6 hour rainfall > 8mm 12 hour rainfall >12mm 24 hour rainfall >15mm	1 hour rainfall > 4mm 6 hour rainfall > 12mm 12 hour rainfall >18mm 24 hour rainfall >25mm	1 hour rainfall > 6mm 6 hour rainfall > 20mm 12 hour rainfall >30mm 24 hour rainfall >40mm
2 Weather on the ground	This is a check that the weather on the ground is no worse than the forecasted weather	Not applicable	If ground conditions are worse than expected be cautious about proceeding	Check ground conditions match forecast	Check ground conditions match forecast	Check ground conditions match forecast
3 Turbidity measurements	Depending on the project, turbidity will be through at least twice daily hand held readings upstream and downstream of pathway to the river, or turbidity will be continuously measured by loggers upstream and downstream of pathway to the river, with alarm triggers. A 20% rise in Turbidity should always trigger an investigation. An exact turbidity level also needs to be decided above which works are suspended for investigation and remedial action. The example shows a trigger of 5NTU, as most *Margaritifera* waters have an NTU of <1	Check upstream and downstream turbidity match and there are no outside sources of sediment between the monitoring locations	At least twice daily during Trigger 2 and 3 items, at least hourly during Trigger 1 items	Turbidity 20% above upstream levels: amber warning - investigation by ECoW and Contractor Turbidity above 5 NTU: red warning - suspension of works and immediate corrective actions	Turbidity 20% above upstream levels: amber warning - investigation by ECoW and Contractor Turbidity above 5 NTU: red warning - suspension of works and immediate corrective actions	Turbidity 20% above upstream levels: amber warning - investigation by ECoW and Contractor Turbidity above 5 NTU: red warning - suspension of works and immediate corrective actions
4 Soil conditions on the ground	This Trigger checks that the soils in the works area are not so saturated that they could result in slippage , soil movement, or overland flow of contaminated water.	No overland flow pathways for water. Very wet areas outside the main works can be managed using further silt fencing	If wet, check soil saturation levels regularly during the day	Wet conditions: amber warning for corrective measures Overland flow: suspension of works until soil is dry enough to continue	Wet conditions: amber warning for corrective measures Overland flow: suspension of works until soil is dry enough to continue	Wet conditions: amber warning for corrective measures Overland flow: suspension of works until soil is dry enough to continue

Table 6.4: Examples of triggers inserted into SOWOR spreadsheet

			Commencement Triggers				Abandonment Triggers			
1 Activity	**2 Work Item**	**6 Risk Level** 1: very high 2: intermediate 3: low risk	**7 Commencement trigger 1**	**8 Commencement trigger 2**	**9 Commencement trigger 3**	**10 Commencement trigger 4**	**11 Abandon trigger 1**	**12 Abandon trigger 2**	**13 Abandon trigger 3**	**14 Abandon trigger 4**
1	Confirm the absence of freshwater mussels	3 – not construction work, survey only if survey licence conditions are met	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Exclusion fencing with sediment control	2	1 hour rainfall < 4mm 6 hour rainfall < 12mm 12 hour rainfall <18mm 24 hour rainfall <25mm	Weather conditions on the ground are no worse than the forecast	Turbidity <20% above upstream levels Turbidity < 5 NTU	Overland flow: No commencement until soil is dry enough to continue	1 hour rainfall > 4mm 6 hour rainfall > 12mm 12 hour rainfall >18mm 24 hour rainfall >25mm	Weather conditions are worse that the forecast and are equivalent to abandon trigger 1	Turbidity levels higher than agreed trigger of total value	Overland flow is occurring or imminent
3	Delivery of Site Compound units	3	1 hour rainfall < 6mm 6 hour rainfall < 20mm 12 hour rainfall <30mm 24 hour rainfall<40mm	Weather conditions on the ground are no worse than the forecast	Turbidity <20% above upstream levels Turbidity < 5 NTU	Overland flow: No commencement until soil is dry enough to continue	1 hour rainfall > 6mm 6 hour rainfall > 20mm 12 hour rainfall >30mm 24 hour rainfall>40mm	Weather conditions are worse that the forecast and are equivalent to abandon trigger 1	Turbidity levels higher than agreed trigger of total value	Overland flow is occurring or imminent
8	Excavation of pipe trench	1	1 hour rainfall < 2mm 6 hour rainfall < 8mm 12 hour rainfall <12mm 24 hour rainfall <15mm	Weather conditions on the ground are no worse than the forecast	Turbidity <20% above upstream levels Turbidity < 5 NTU	Wet conditions: amber warning for corrective measures before commencement Overland flow: No commencement until soil is dry enough to continue	1 hour rainfall > 2mm 6 hour rainfall > 8mm 12 hour rainfall >12mm 24 hour rainfall >15mm	Weather conditions are worse that the forecast and are equivalent to abandon trigger 1	Turbidity levels higher than agreed trigger of total value	Overland flow is occurring or imminent

Table 6.5: Example of Columns 15-21 in the SOWOR Spreadsheet

					Actual conditions documented				
1 Activity	**2 Work item**	**6 Risk Level** 1: very high 2: intermediate 3: low risk	**15 Actual date commenced**	**16 Date completed**	**17 Trigger 1 Actual forecast**	**18 Trigger 2 Actual weather conditions**	**19 Trigger 3 Actual turbidity measured u/s and d/s**	**20 Trigger 4 Actual soil wetness conditions**	**21 Comments Include any stoppages or remedial actions**
1	Confirm the absence of freshwater mussels	3 – not construction work, survey only if survey licence conditions are met	30/4/23	30/4/23	N/A	N/A	N/A	N/A	
2	Exclusion fencing with sediment control	2	01/05/23	03/05/23	No rain	No rain observed	Turbidity < 1 NTU	Soil dry	
3	Delivery of Site Compound units	3	04/05/23	04/05/23	No rain	No rain observed	Turbidity < 1 NTU	Soil dry	
8	Excavation of pipe trench	1	09/05/23	11/5/23	6 hour rainfall > 8mm Then rain stopped completely by 8pm on 08/05/23	Rain stopped as per forecast	Turbidity < 1 NTU	Soil dry	This work item was delayed by 1 day due to high rainfall, although the ground remained very dry as it followed a long dry spell

7 CONTRIBUTING TO ONGOING KNOWLEDGE AND STANDARDS FOR *MARGARITIFERA*

7.1 Reporting of the SOWOR

There is a dearth of scientific data on the adequacy of mitigation measures for *Margaritifera*. The conservation objectives for all Irish Natura 2000 populations is to restore sustainable conditions of flow, trophic status and sediment condition. It is essential to document all construction management methodologies and mitigation in order to provide an evidence-based set of methodologies and mitigation protocols to safeguard the ongoing restoration process into the future.

On this basis the SOWOR must be accurately filled in as a record of the scheme implementation and to record the mitigation measures applied and the success of same. This is also helpful to the contractor, as it can highlight pollution caused by a third party than could otherwise be blamed on the project works.

The SOWOR method of undertaking project construction and operation was developed to provide a standard of excellence in practice, documentation and compliance that can achieve the aim of safe removal of construction risk, improvement of the knowledge base for future applications, and for construction companies to demonstrate that they are safe and reliable partners in good conservation practice.

Planning conditions for projects within *Margaritifera* catchments should require a return of the completed SOWOR as part of the permitted compliance documents.

7.2 Monitoring the Success or Failure of Mitigation Measures

When a project has been granted permission there are usually many planning conditions to ensure that all the mitigation measures proposed are undertaken. Demonstration of compliance with the planning permission, sometimes following extended monitoring of the mitigation measures, and sometimes with ongoing licencing requirements during the operational stage closes the loop and completes the process.

The effectiveness of mitigation or control measures committed to as part of a plan or project will depend on appropriate implementation and local site conditions (including factors like slope, drainage and characteristics of the receiving environment) which further reinforces the requirements for detailed baseline surveys and appropriately design mitigation. In all cases the statutory burden of proof lies with the project proponent, developer or operator of the activity to show conclusively beyond reasonable scientific doubt that the control measure, or combination of measures will mitigate any significant impact on *Margaritifera* based on the conservation objectives and supporting water quality standards.

The amended EIA Directive (European Parliament & Council of the European Union 2014) introduced the requirement for monitoring obligations, which can apply to both the implementation and management of the project.

CIEEM's 'Guidelines for Ecological Impact Assessment in the UK and Ireland' requires that any ecological assessment should identify where monitoring is required for mitigation and enhancement measures (CIEEM, 2018). The monitoring programme needs to set out the methods to be used, the criteria for determining success/failure, appropriate timing, mechanisms for implementation, frequency and duration of monitoring, and frequency of reporting. The SOWOR offers an effective way to monitor whether the mitigation measures are effective and provides a mechanism to manage the risk to *Margaritifera* and, where necessary to abandon construction activities where significant risk is identified.

As outlined in the Guidelines for Ecological Impact Assessment, monitoring may be used to determine:

- whether the measures have been implemented as agreed
- the success/effectiveness of the measures
- early warning of proposed measures which are not proving effective
- how to remedy the situation should any of the implemented measures fail e.g., due to lack of management.

Monitoring should be secured through a planning condition or obligation built into legal agreements, which the proponent must implement fully.

7.3 Feedback on Success or Failure of Mitigation Measures – Contributing to the Future of *Margaritifera*

It is vital that we improve the evidence base for the effectiveness of mitigation measures to protect or restore the conservation status of *Margaritifera* from the impacts of development. The most effective way to achieve this is likely to be through a collaboration with the relevant industry, the bodies responsible for environmental protection and nature conservation and academia. For example, when a number of completed SOWORs have been returned, an analysis of mitigation methodologies and outcomes should be undertaken, perhaps as part of a postgraduate student project.

Ambitious targets to aim for must be set and whilst improving the evidence for the effectiveness of mitigation measures is a challenge, it is not an impossible one. In addition, an evidence base which demonstrates that something doesn't work, or might not work, is better than recommending mitigation measures without any evidence to support their application.

Options to share information and experiences about the effects of impacts, the success of implementing mitigation and monitoring programmes should be explored. A central repository providing an evidence base to inform design, construction methods statements and operational plans for plans and projects should be considered at a national, if not international scale.

Initiatives such as the SOWOR system which has been designed to implement the post-design, post-permission construction stage safely and to provide a monitoring record that can be used to inform future designs, method statements and mitigation effectiveness, could be accessed from this central repository and seek to protect or improve the conservation status of *Margaritifera* across Ireland and beyond. A web base platform is likely to be the most efficient way of achieving this goal and organisations such as CIEEM are already looking at the development of such as system to improve ecological assessment.

7.4 Opportunities to Support the Restoration of *Margaritifera* in Ireland

As part of the planning process within a *Margaritifera* SAC catchment, it will be necessary to demonstrate, at the very least, that a proposed plan or project will not affect the maintenance of favourable condition or prevent the restoration of *Margaritifera* within that catchment throughout its lifetime. Within a non-SAC catchment, it will be necessary to demonstrate that the plan or project will not negatively affect the *Margaritifera* population throughout its lifetime (see Figure 6.1). However, developers and public authorities are encouraged to incorporate measures that will work towards the restoration of *Margaritifera* populations into plans and projects. Such measures will be largely context dependent based on the location of the project within the catchment and local hydrological and hydrogeological context. A good understanding of the expected natural habitat (i.e., in the absence of human influence) and the existing baseline is therefore vital to determine measures that can reasonably be undertaken. The extent of human influence with river catchments is often extensive, poorly understood and sometimes forgotten (see Wohl, 2019), and this is an important issue to be aware of when designing and planning any restoration measures.

At this point, it is useful to reiterate the key pressures on *Margaritifera* populations within Irish rivers, as any measures to aid in the restoration of *Margaritifera* will need to be tailored to address these pressures. As outlined in section 1, the core issues affecting *Margaritifera* in Irish rivers are:

- Nutrient enrichment
- Siltation of the riverbed
- Alterations of the natural flow regime

Therefore, any measures which work towards alleviating the above pressures within a *Margaritifera* catchment are likely to work towards their long-term conservation.

Consultation with the NPWS and *Margaritifera* experts is strongly advised to ensure that before they are undertaken, restoration actions for *Margaritifera* are both appropriate and likely to be effective. Effective restoration of *Margaritifera* populations requires a concerted effort at the river catchment level, and therefore local measures must be informed by restoration goals within the wider catchment.

Within Ireland, much restoration effort has been focused on farming and forestry, for example as part of Kerry LIFE[25] and the Pearl Mussel Project[26]. The measures typically include fencing riverbanks to prevent livestock access, providing alternative water sources for livestock, blocking drains, treating invasive flora, upgrading farm tracks, mobile sheep dipping and sheep dipping alternatives. For many plans and projects, the incorporation of the above measures may not be possible, nevertheless, depending on the context, it may be possible to incorporate additional measures into a plan or project that go beyond the basic requirement of not negatively affecting *Margaritifera* or not preventing their restoration (in SAC rivers).

The following sections outlines and describe some of the measures that can be undertaken as part of a plan or project that work towards the restoration of *Margaritifera* habitat and *Margaritifera* populations.

Riparian Buffers

Maintaining or restoring riverside habitat can play an important role in the protection and restoration of *Margaritifera*. Riparian buffers are measures typically utilised in agricultural land to reduce silt and nutrient inputs into watercourses. Riparian buffer strips are essentially bands of land adjacent to rivers, streams and drains that are removed from intensive production and contain permanent vegetation. These strips of vegetation are designed in such a way that the vegetation within the strip removes sediment, nutrients and pesticides associated with surface water runoff (Ó hUallacháin, 2014). Riparian buffer strips perform many additional ecological functions, such as providing habitat for flora and fauna, stabilising banks, providing woody habitat for rivers, and their application outside of the agriculture sector is becoming more common. For example, Inland Fisheries Ireland (IFI) launched guidance in 2020 on the protection of urban watercourses through the use of buffer zones, sustainable drainage systems, instream rehabilitation, climate / flood risk and recreational planning (IFI, 2020).

The introduction of riparian buffer strips where none existed before could work towards the restoration of *Margaritifera* populations within a river catchment. However, the management/restoration of these riparian buffer strips is context dependent. For example, although tree planting is often recommended for restoring degraded river systems, in *Margaritifera* catchments with open peat habitat, the maintenance of wet, open conditions is essential. In such catchments, the planting of trees is likely to affect the natural hydrological and hydrogeological regime (Flynn et al., 2022; Kuemmerlan et al, 2021) and therefore negatively affect *Margaritifera*. Therefore, in open peat *Margaritifera* catchments, trees (native or otherwise) should not be planted in areas where they could result in impacts on the hydrological regime of a watercourse. A buffer of *Juncus* grassland is effective in this context, and can be managed not to dry to scrub, but should generally maintained by wetness. Indeed, it may be desirable to remove conifer trees from peatland sites as part of a restoration effort. Conifer removal is a "supporting action" (a voluntary measure that a farmer may choose to undertake with the aim of improving their habitat quality or whole-farm score) under the Pearl Mussel Project.

In contrast to *Margaritifera* catchments with peat, in catchments with mineral soils, trees are less likely to influence the hydrological regime of rivers, and may therefore have a positive role in nutrient and sediment removal, on land where there is little potential for soil water storage. However, excessive shading of *Margaritifera* habitats within the river channel by trees should be avoided.

A potential approach to improving the condition of riparian buffers in *Margaritifera* catchments could be to utilise the score cards developed by the Pearl Mussel Project, which are used to assess the quality of grassland, scrub/woodland and peatland habitat within a *Margaritifera* catchment[27]. The scorecards award marks for various aspects of the habitat which reflect quality such as plant species, vegetation structure, wetness, exposed soil, and damaging activities. Once an understanding of the quality of the existing habitat is obtained, actions could then be taken to improve the habitat (e.g., by stopping any damaging activities or managing invasive flora).

Drain Blocking & Bog Restoration

The negative effects of land drainage on water quality and hydrological processes within river catchments is well understood. The blocking of drains can be an effective method of improving water quality and restoring natural hydrological regimes in watercourses. Check or leaky dams are typically installed in artificial drains to slow the flow of water, and can have the added benefit of trapping nutrient and sediments. By reducing the

[25] https://webgate.ec.europa.eu/life/publicWebsite/project/details/4112

[26] https://www.pearlmusselproject.ie/

[27] https://www.pearlmusselproject.ie/resources/publications.html

negative effects of land drainage, check dams can help towards the restoration of *Margaritifera* habitat. Check dams typically comprise loose, clean, stone, or wood to form a porous dam and depending on the local context, may need to be installed in a series to be effective (PMP, 2020).

The effectiveness of drain blocking as a measure to restore hydrological conditions in previously degraded blanket bogs has been demonstrated in Finland by Menberu et al. (2016). Menberu et al. (2016) found that the changes in water table characteristics following the restoration of degraded blanket bog were indicative of the creation of favourable hydrological conditions for recovery of functional peatland ecosystems. The installation of peat plugs and wooden ply plastic dams in drains to restore the natural hydrological function of bogs is a supporting action for *Margaritifera* as part of the Pearl Mussel Project (PMP, 2020).

Forest to bog restoration where open peat habitats were planted for forestry ("legacy forests") is also recommended as a hydrological restoration tool (Hermens et al., 2019).

Public Awareness

Although creating public awareness of the importance and plight of *Margaritifera* in Ireland will not directly result in restoration measures for the species, where a plan or project requires buy in from landowners or other third parties, the measures necessary for their conservation could be explained, as well as any measures actively being undertaken by the plan or project.

7.5 Recommendations on how Guidance should Feed Back into the Planning System

The guidance note is intended to assist agencies, public authorities and other key stakeholders in relation to proposed activities, plans or projects within, or possibly impacting on *Margaritifera* catchments. The ultimate aim of the guidance note is to ensure sustainable development in pearl mussel catchments by identifying critical risk factors and possible mitigation for specific activities. Therefore, it is recommended that all stakeholders read and are mindful of this guidance note in advance of the planning or undertaking of any proposed plan or project within a *Margaritifera* catchment. This note should be taken into account prior to decisions being made in relation to any proposed plans and projects within a *Margaritifera* catchment.

7.6 Recommendations on Publication of Guidance

As noted previously, the purpose of this guidance is to assist agencies, public authorities and other key stakeholders in relation to proposed activities, plans or projects within, or possibly impacting on *Margaritifera* catchments. Therefore, this document should be made available and easily accessible to all stakeholders. As demonstrated in the above sections, the assessment of the potential impact of a plan or project on *Margaritifera* can be complex and may require extensive and expensive survey and mitigation. It is important that public authorities, planners, developers and consultants are fully aware of these potential limitations in advance of planning a project.

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SUPPLEMENTARY GUIDANCE ON ASSESSMENT AND CONSTRUCTION MANAGEMENT IN *MARGARITIFERA* CATCHMENTS IN IRELAND:

BLACKWATER RIVER (CORK/WATERFORD) SAC

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QUICK ACCESS 1 - CONSERVATION OBJECTIVES

The table below outlines the Site-Specific Conservation Objectives for the three populations of *Margaritifera* in the Blackwater River (Cork/Waterford) SAC 002170 that should be the basis for assessment for projects that could impact the *Margaritifera* populations within this SAC. The table is extracted directly from the Conservation Objectives (CO) Document[1] and should be read in conjunction with the maps etc. provided.

Conservation Objective	Measure	Target for SAC	Notes
Distribution	Kilometres	Maintain at 161km	The freshwater pearl mussel is known from the main Blackwater River, two tributaries (Owentaraglin and Allow) and the Licky River, which discharges to the Upper Blackwater Estuary. 168km encompasses the length of channel from the most upstream records of the freshwater pearl mussel to the most downstream records of live mussels, and contained within the freshwater pearl mussel catchment boundaries displayed on map 8 (of https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002170.pdf).
Population Size	Number of Adult Mussels	Restore to 35,000 adult mussels	The SAC has three populations listed on the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations of 2009 (Government of Ireland, 2009b): Munster Blackwater, Allow (Munster Blackwater) and Licky. The separation of the main channel Blackwater and Allow into two populations is artificial and no longer considered appropriate. The Licky, however, is a distinct population, being separated from the Blackwater by brackish water and a hydrological distance of approx. 30km, making genetic exchange very unlikely. Information on the size of the population in the Blackwater and its tributaries is poor, but estimated at less than 10,000 for the Blackwater main channel (target set at 10,000); and between 10,000 and 20,000 for the Allow tributary (target set at 15,000) (DEHLG, 2010a, 2010b). The Licky population was estimated as just greater than 10,000 in 2005, but was estimated to have declined to approx. 4,700 by 2009 (target set at 10,000) (Ross, 2005; DEHLG, 2010c).
Population Structure: Recruitment	Percentage per size class	Restore to least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length	Mussels of no more than 65mm are considered 'young mussels' and may be found buried in the substratum and/or beneath adult mussels. Mussels of no more than 30mm are 'juvenile mussels' and are always buried in the substratum. The Blackwater population is believed to be composed entirely of aged adults, with no evidence of recruitment for at least 20 years (DEHLG, 2010a). No juvenile mussels were found in the Allow and 8.3% of the population was no more than 65mm in length in 2009 (DEHLG, 2010b). No young or juvenile mussels were recorded in the Licky during monitoring in 2005 or 2009 and there was no evidence that recruitment had occurred in at least 12 years, with the smallest mussel in 2009 measuring 85.3mm (Ross, 2005; DEHLG 2010c)
Population Structure: adult mortality	Percentage	No more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution	5% is considered the cut-off between the combined errors associated with natural fluctuations and sampling methods and evidence of true population decline. 1% of dead shells is considered to be indicative of natural losses. The Allow passed the target for live adults, but failed that for dead shells in 2009 (DEHLG, 2010b). The Blackwater and Licky failed both targets in 2009 (DEHLG, 2010a, 2010c).

[1] https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002170.pdf

Conservation Objective	Measure	Target for SAC	Notes
Habitat Extent	Kilometres	Restore suitable habitat in more than 35km (see map 8) and any additional stretches necessary for salmonid spawning	The species' habitat covers stretches of very large, high energy, lowland rivers (Blackwater) and a short coastal river (Licky); and is a combination of 1) the area of habitat adult and juvenile mussels can occupy and 2) the area of spawning and nursery habitats the host fish can occupy. Fish nursery habitat typically overlaps with mussel habitat. Fish spawning habitat is generally adjacent to mussel habitat, but may lie upstream of the generalised mussel distribution. Only those salmonid spawning areas that could regularly contribute juvenile fish to the areas occupied by adult mussels should be considered. The availability of mussel habitat and fish spawning and nursery habitats are determined by flow and substratum conditions. The habitat for the species is currently unsuitable for the survival of adult mussels or the recruitment of juveniles. The target is based on the stretches of river identified, from a combination of dedicated survey and incidental records, as having suitable habitat for the species. As there has been no full baseline survey, the quality of the data from the Blackwater and its tributaries is poor.
Water Quality: Macroinvertebrate and phytobenthos (diatoms)	ecological quality ratio (EQR)	Restore water quality- macroinvertebrates: EQR greater than 0.90; phytobenthos: EQR greater than 0.93	These EQRs correspond to high ecological status for these two Water Framework Directive biological quality elements. They represent high water quality with very low nutrient concentrations (oligotrophic conditions). The habitat in the Blackwater and Licky failed both standards during 2009 sampling for the Sub-basin Management Plans, while the Allow failed the macroinvertebrate target (DEHLG, 2010a, 2010b, 2010c). See also The European Communities Environmental Objectives (Surface Water Objectives) Regulations 2009 (Government of Ireland, 2009a).
Substratum quality: filamentous algae (macroalgae), macrophytes (rooted higher plants)	Percentage	Restore substratum quality- filamentous algae: absent or trace (<5%)	Significant growth of macrophytes was found at some sites in all three populations sampled during 2009 for the Sub-basin Management Plans (DEHLG, 2010a, 2010b, 2010c). Filamentous algae were below the target at all sites sampled in the Allow, however significant growths were detected at some sampling sites in the Blackwater and Licky (DEHLG, 2010a, 2010b, 2010c). Recruitment of juvenile mussels is being prevented by the poor quality of the river substrate.
Substratum Quality: Sediment	Occurrence	Restore substratum quality- stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment	The habitat for the species is currently unsuitable for the recruitment of juveniles owing to sedimentation of the substratum. In some locations, it is also unsuitable for the survival of adult mussels, notably stretches of the Licky (DEHLG, 2010c). Significant sedimentation has been recorded during all recent mussel monitoring surveys, particularly in the Licky and Allow (DEHLG, 2010a, 2010b, 2010c). Recruitment of juvenile mussels is being prevented by the poor quality of the river substrate.
Substratum Quality Oxygen availability	Redox potential	Restore to no more than 20% decline from water column to 5cm depth in substrate	Differences in redox potential between the water column and the substrate correlate with differences in oxygen levels. Juvenile mussels require full oxygenation while buried in gravel. In suitable habitat, there should be very little loss of redox potential between the water column and underlying gravels. Redox potential data are currently only available from the Allow, where loss in 2009 was 31.5 - 44.1% at 5cm depth (DEHLG, 2010b).
Hydrological Regime: Flow variability	Metres per second	Restore appropriate hydrological regimes	The availability of suitable freshwater pearl mussel habitat is largely determined by flow (catchment geology being the other important factor). In order to restore the habitat for the species, flow variability over the annual cycle must be such that: 1) high flows can wash fine sediments from the substratum, 2) low flows do not exacerbate the deposition of fines and 3) low flows do not cause stress to mussels in terms of exposure, water temperatures, food availability or aspects of the reproductive cycle.

Conservation Objective	Measure	Target for SAC	Notes
Host Fish	Number	Maintain sufficient juvenile salmonids to host glochidial larvae	Salmonid fish are host to the larval form of the freshwater pearl mussel and, thus, they are essential to the completion of the life cycle. 0+ and 1+ fish are typically used, both because of the habitat overlaps and the development of immunity with age in the fish. Fish presence is considered sufficient, as higher densities and biomass of fish are indicative of enriched conditions in mussel rivers. Geist et al. (2006) found that higher densities of host fish coincided with eutrophication, poor substrate quality for pearl mussels and a lack of pearl mussel recruitment, while significantly lower densities and biomass of host fish were associated with high numbers of juvenile mussels. Fish movement patterns must be such that 0+ fish in the vicinity of the mussel habitat remain in the mussel habitat until their 1+ summer. No fish stocking should occur within the mussel habitat, nor any works that may change the salmonid balance or residency time. The Allow and Licky freshwater pearl mussel populations appear to favour native brown trout (Salmo trutta), therefore, it is particularly important that these are not out-competed by stocked fish (DEHLG, 2010b, 2010c). No data on fish preferences are available for the Blackwater.

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1 INTRODUCTION

1.1 Background and Purpose of Guidance Note

The freshwater pearl mussel, *Margaritifera margaritifera*, is acknowledged to be one of the most demanding species of high water quality and high river bed quality in the world. Due to the extreme sensitivity of *Margaritifera*, all land use activities in a catchment supporting this species must be in keeping with the needs of a thriving mussel population. Just one damaging activity can destroy conservation efforts in the rest of the catchment.

Whilst Ireland supports a significant proportion of the *Margaritifera* populations remaining in Europe, these populations have been in dramatic decline in recent years, with an estimated decline of between 12.6% - 32.7 % between the 2007-2012 and 2013 – 2018 monitoring periods (NPWS, 2019). The species is on the IUCN Red List of Threatened Species and throughout the island of Ireland it is rated as critically endangered.

This supplementary guidance document relates to the freshwater pearl mussel and its habitat within the Blackwater River (Cork/Waterford) SAC (002170). The guidance is based on legal responsibilities and current best environmental practice relating to *Margaritifera* conservation. It is not a legal interpretation, and is not intended to replace existing guidance for other species or habitats but is intended to assist in considering the potential effects of relevant developments, works and activities on *Margaritifera* and its conservation interests.

The Habitats Directive requires Member States to take measures that are designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest. *Margaritifera* is such a species of Community interest, and in order to achieve the conservation objectives above, Special Areas of Conservation (SAC) have been established to protect mussels and their habitat. In addition, to achieving favourable conservation status, the natural range of *Margaritifera* must not be reduced so that there will continue to be a sufficiently large habitat to maintain its populations on a long-term basis.

The main objective of this supplementary guidance is to inform plan makers and project proponents who are proposing to develop plans or projects within the Blackwater River (Cork/Waterford) SAC (002170):

- Where information on *Margaritifera* can be found;
- The legal responsibilities in the context of the Blackwater River (Cork/Waterford) SAC. Legal obligations with respect to the National and European legislation is dealt with in the main Guidance document "*Guidance on Assessment and Construction Management in Margaritifera Catchments*" (see section 1.2);
- Whether the implementation of the plan or development in the catchment can be undertaken in a manner that is consistent with the conservation objectives for *Margaritifera* and if so how it can be constructed safely;
- Mitigation likely to be required to ensure the conservation objectives for *Margaritifera* are not compromised by the plan or project;
- How a plan or project can contribute to the ongoing knowledge, understanding and standards for *Margaritifera* in the Blackwater River (Cork/Waterford) SAC.

1.2 How this document fits in with "Guidance on Assessment and Construction Management in *Margaritifera* Catchments"

This supplementary guidance document is intended to provide advice on how the main guidance (under separate cover) is implemented in the Blackwater River (Cork/Waterford) SAC (002170). This document refers back to the main guidance document where general issues and sections that are not specific to the Blackwater River (Cork/Waterford) SAC (002170) are considered. This is to ensure that unnecessary repetition is avoided and the focus of this guidance is on the *Margaritifera* population in the Blackwater River (Cork/Waterford) SAC (002170). It is therefore essential that this guidance document is only read following a full reading of the Guidance on Assessment and Construction Management in *Margaritifera* Catchments.

2 THE STATUS OF *MARGARITIFERA* IN THE BLACKWATER RIVER (CORK/WATERFORD) SAC (002170)

2.1 Introduction

The Blackwater River (Cork/Waterford) SAC (002170) consists of the freshwater stretches of the River Blackwater as far upstream as Ballydesmond, the tidal stretches as far as Youghal Harbour and many tributaries, the larger of which include the Licky, Bride, Flesk, Chimneyfield, Finisk, Araglin, Awbeg (Buttevant), Clyda, Glen, Allow, Dalua, Brogeen, Rathcool, Finnow, Funshion, Owentaraglin and Awnaskirtaun (NPWS, 2016). The Blackwater or Munster Blackwater is the main river which flows through counties Kerry, Cork and Waterford. It rises in the Mullaghareirk Mountains in County Kerry and then flows in an easterly direction through County Cork, through Mallow and Fermoy. It then enters County Waterford where it flows through Lismore before abruptly turning south at Cappoquin and finally draining into the sea at Youghal Harbour. In total, the Munster Blackwater is 120 km long. It is notable for being one of the best salmon fishing rivers in the country.

Three *Margaritifera* populations are known within the Blackwater River (Cork/Waterford) SAC (002170). All three populations are named in S.I. No. 296/2009 - The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. The populations comprise:

1. The population in the main Blackwater River (referred to as the Munster Blackwater population), although this population extends into the Owentaraglin and Funshion tributaries.
2. The population within the Allow (referred to as the Allow (Munster Blackwater) population) and,
3. The population within the Licky River (referred to as the Licky population), which discharges to the Upper Blackwater Estuary.

The Munster Blackwater is the largest *Margaritifera* catchment, encompassing an area of 2030 km^2 (excluding the Allow). The Allow *Margaritifera* catchment covers an area of 311 km^2, while the Licky covers an area of 43 km^2. The *Margaritifera* catchment boundaries are shown in Figure 2.1. The Bride River which, whilst part of the Blackwater River (Cork/Waterford) SAC (002170), is not included within the *Margaritifera* sensitive areas mapping and does not have any extant *Margaritifera* populations.

2.2 Catchment Physical Setting

The Munster Blackwater catchment is broadly divided into a poorly drained and peat catchment to its north and west, and a well-drained catchment to its south and east (Figure 2.2). The bedrock aquifer is mixed with karstic influences across the centre of the catchment and is poorly productive with high vulnerability throughout (Figure 2.3). There are a complex range of soil types present in the catchment (Figure 2.5). This map shows "loamy drift" in areas previously represented by a high level of organic content of peaty podzols or peaty gleys (Figure 2.6). The Allow catchment is predominantly a poorly draining catchment. The catchment is dominated primarily by gley soils with some brown earths/podzolics along the river courses and some peat and peaty gleys towards the west. The bedrock aquifer is locally important and moderately productive with mixed vulnerability throughout (Figure 2.3). The Licky comprises a mosaic of well and poorly drained soils with some areas of shallow, rocky, peaty/non-peaty mineral complexes. The bedrock aquifer is locally important and moderately productive with karstic influences towards the west. Groundwater vulnerability is typically moderate and high throughout (Figure 2.3).

The most recent CORINE habitat cover (2018) for the *Margaritifera* catchments within the Blackwater River (Cork/Waterford) SAC (002170) is shown in Figure 2.8. This shows the high level of intensification in the catchments with drained pastureland and tillage fields dominating in the majority of the catchment and plantation forest in areas that had deeper peat bog.

The characteristics of each catchment influence the main pressure and threats to *Margartifera*. Therefore, understanding the physical context of the catchment in which the *Margaritifera* population occurs is important for the conservation of *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002170), and plan developers and project proponents must consider this distinction when assessing the possible implications of their plan or project on the conservation objectives of *Margaritifera*.

2.2.1 Poorly draining and peaty catchment areas

In an unimpacted poorly draining or peaty catchment, stream/river flow regimes are naturally flashy which is consistent with the presence of low productivity and locally productive aquifers. The dominance of poorly drained soil and subsoil drives shallower hydrological processes in the upper catchment. It is this flow regime which influences the mobilisation, transport and delivery of dissolved and particulate substances to rivers and streams including vital detritus for juvenile mussels. Areas of high relief and flashy rainfall runoff responses lead to naturally dynamic landscapes in which fast flowing water can lead to fast flowing streams which are dominated by coarser grained sediments, ranging from sands up to boulders (Waters of Life, 2023).

Whilst the dominance of poorly productive and locally productive aquifers and associated low recharge rates suggest that groundwater makes a minor contribution to total runoff, rivers and streams can maintain significant year-round flow in these areas, largely due to high and frequent effective rainfall. However, the relative contribution of groundwater to runoff will vary during the year; it becomes more important, and in many cases dominant, during the low flow periods. In the case of catchments containing peatland cover, such as the north-western areas of the Munster Blackwater and the Allow, and the north-east area of the Licky, a significant proportion of dry weather flow (base flow) derives from groundwater flowing directly from peat to watercourses, coupled with a lesser proportion that flows through peat and into the underlying inorganic substrate, before discharging to the water course. Consequently, peatland catchments can release water to streams to maintain flow over prolonged periods, thus helping to stabilise aquatic ecosystems (Waters of Life, 2023).

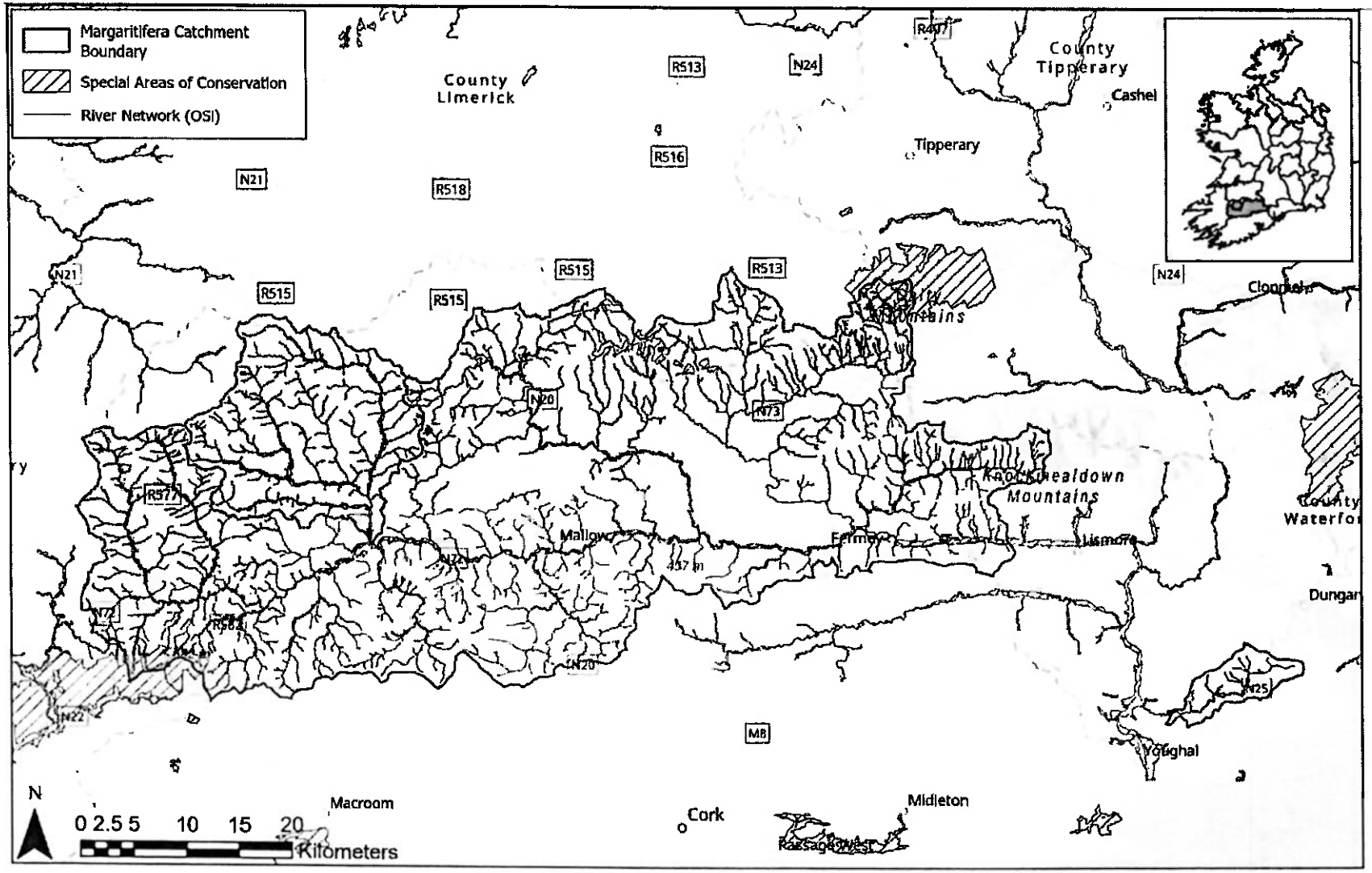

Figure 2.1: Overview of Blackwater River (Cork/Waterford) SAC (002170) and the sub basins of the three *Margaritifera* populations

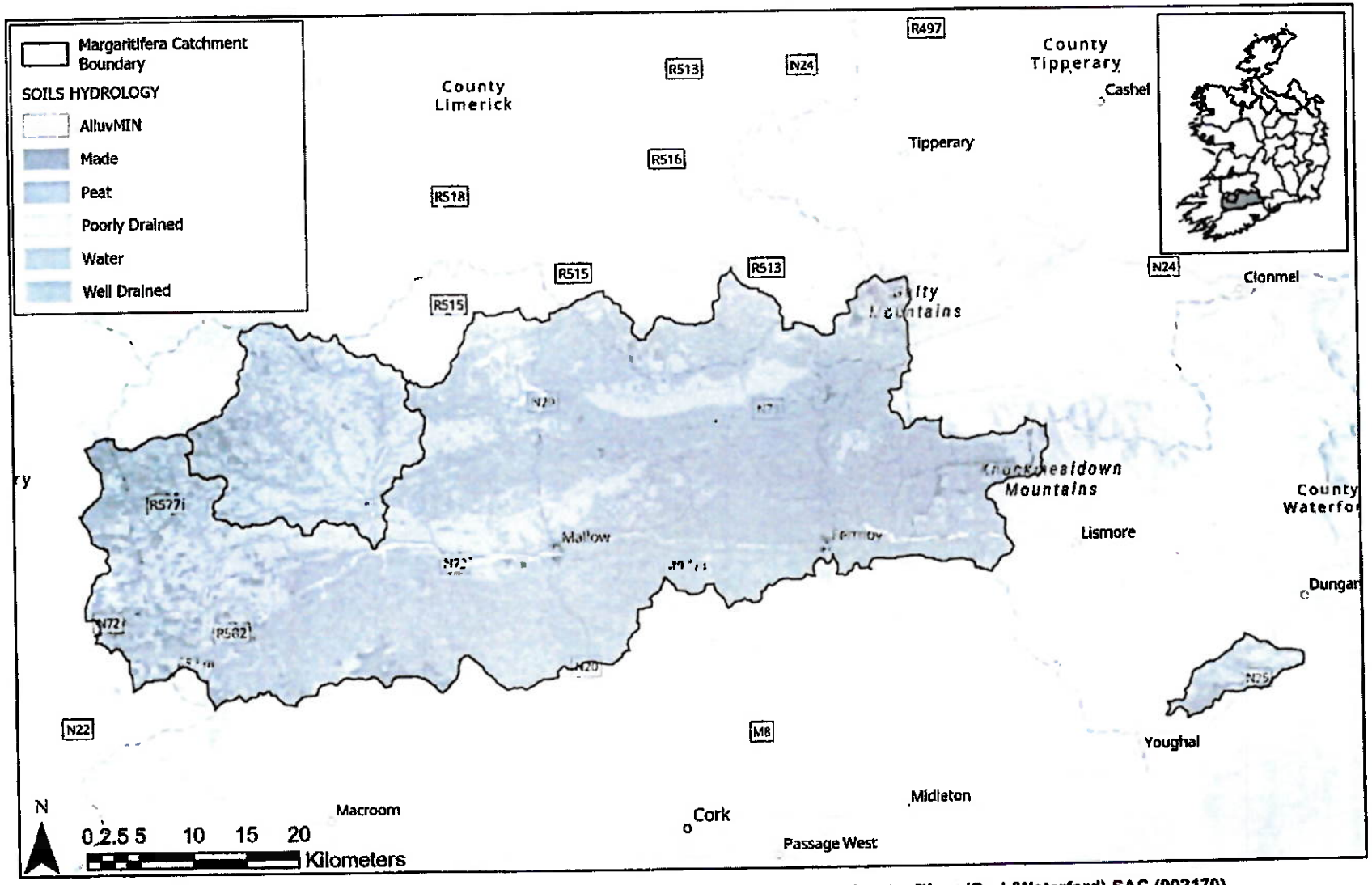

Figure 2.2: Drainage conditions in the sub basins of the three Margaritifera populations in the Blackwater River (Cork/Waterford) SAC (002170)

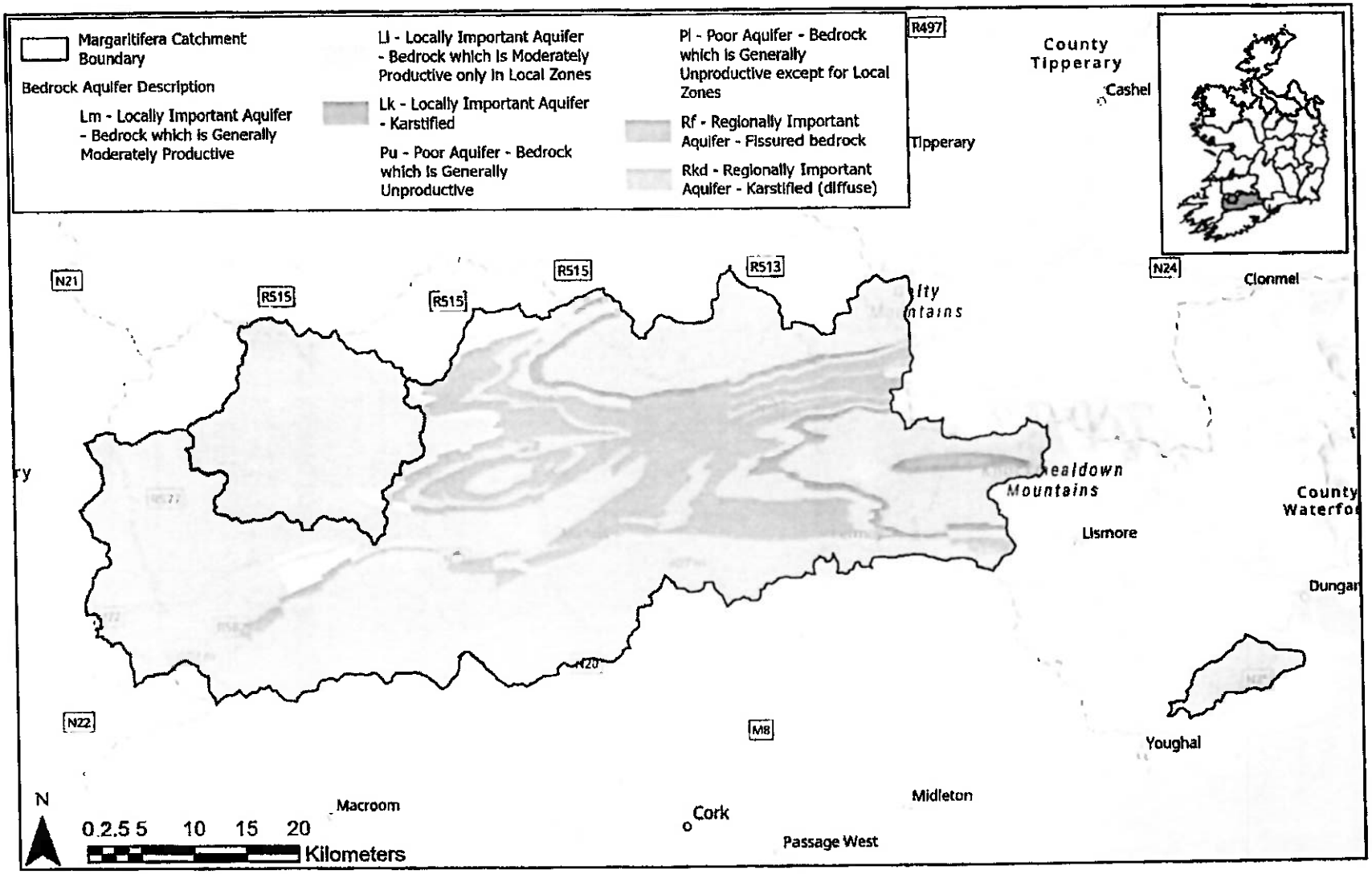

Figure 2.3: The bedrock aquifer in the sub basins of the three Margaritifera populations in the Blackwater River (Cork/Waterford) SAC (002170)

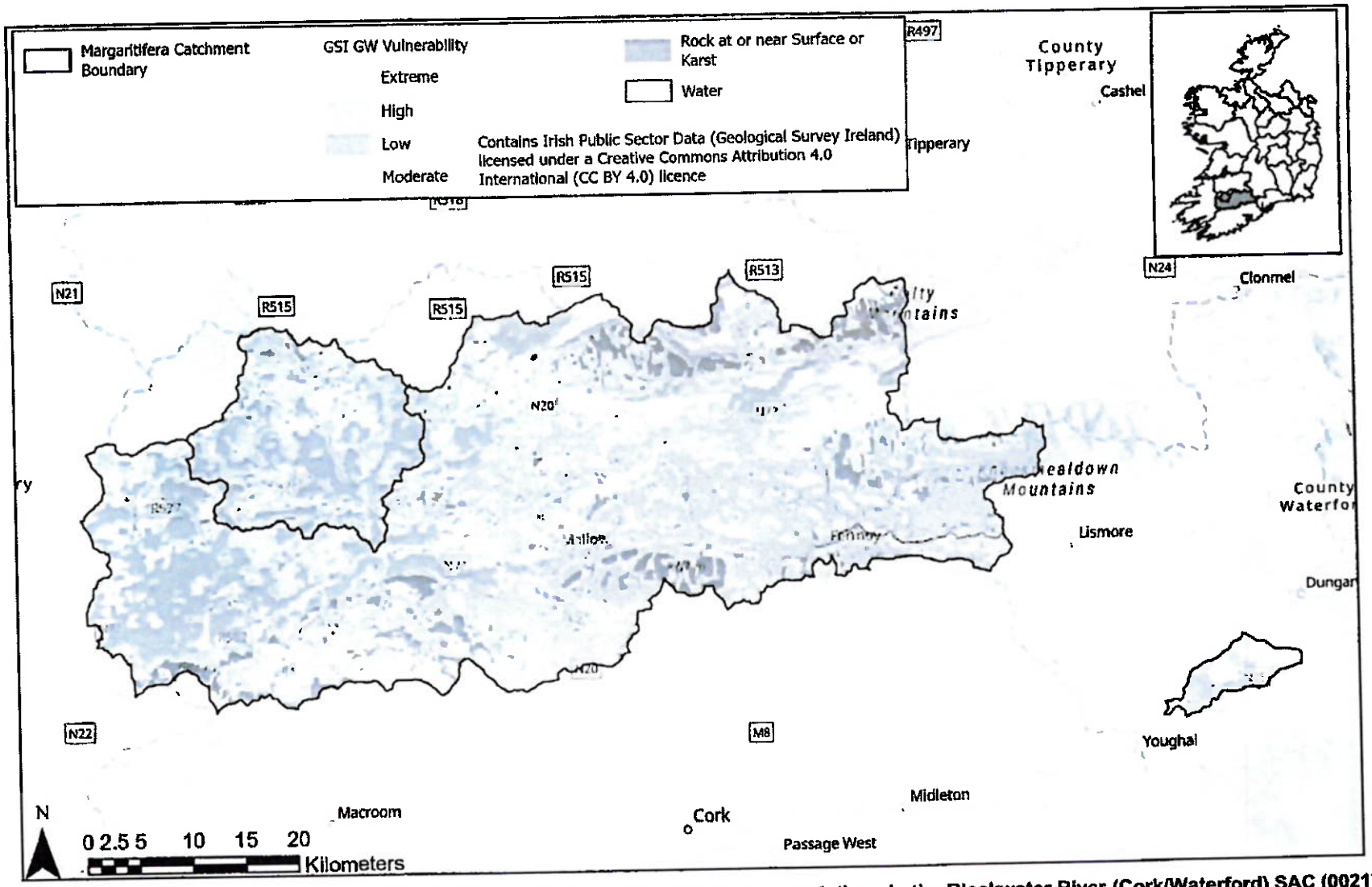

Figure 2.4: Groundwater vulnerability in the sub basins of the three Margaritifera populations in the Blackwater River (Cork/Waterford) SAC (002170)

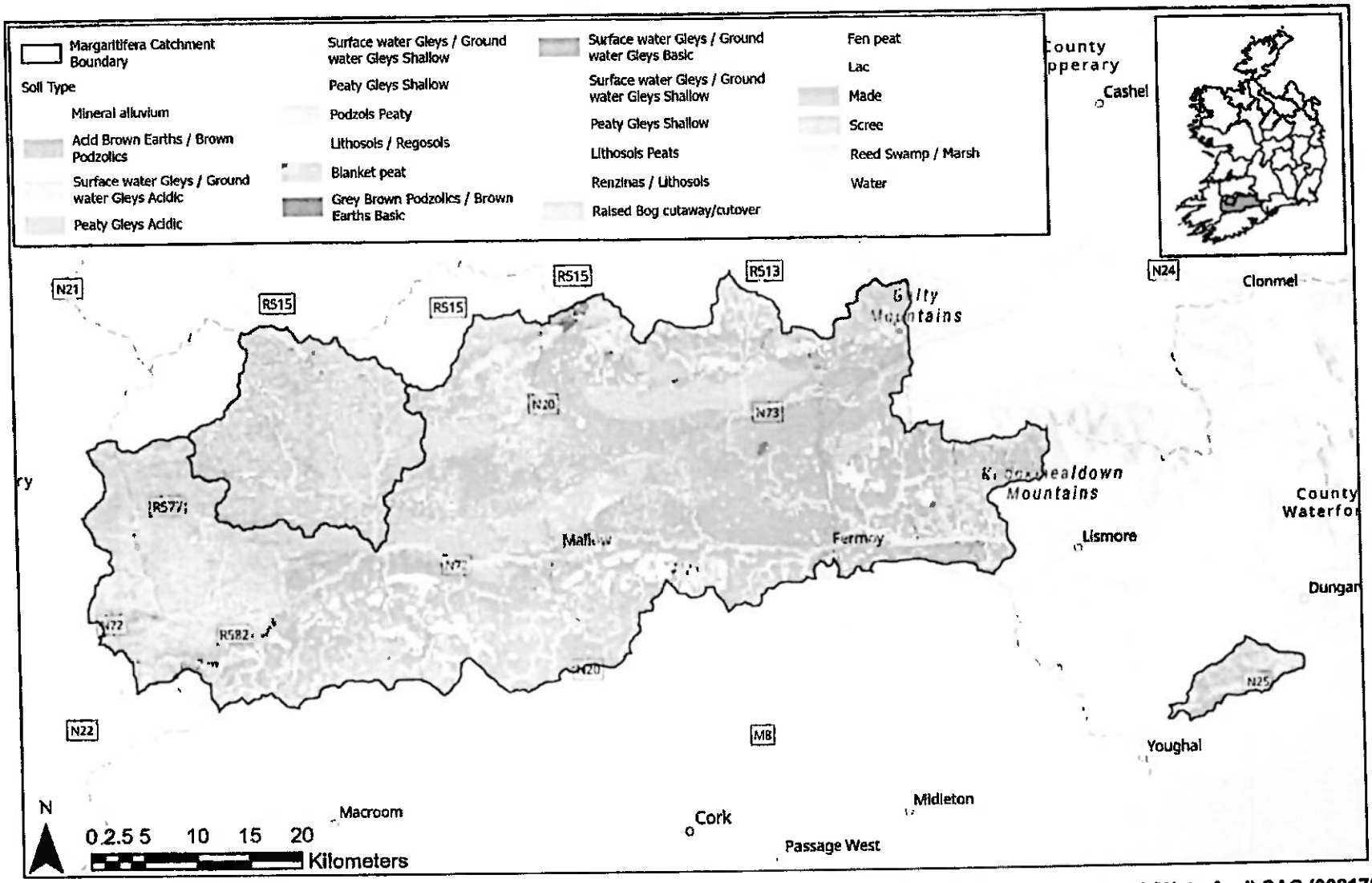

Figure 2.5: Soil types and bare rock in the sub basins of the three Margaritifera populations in the Blackwater River (Cork/Waterford) SAC (002170)

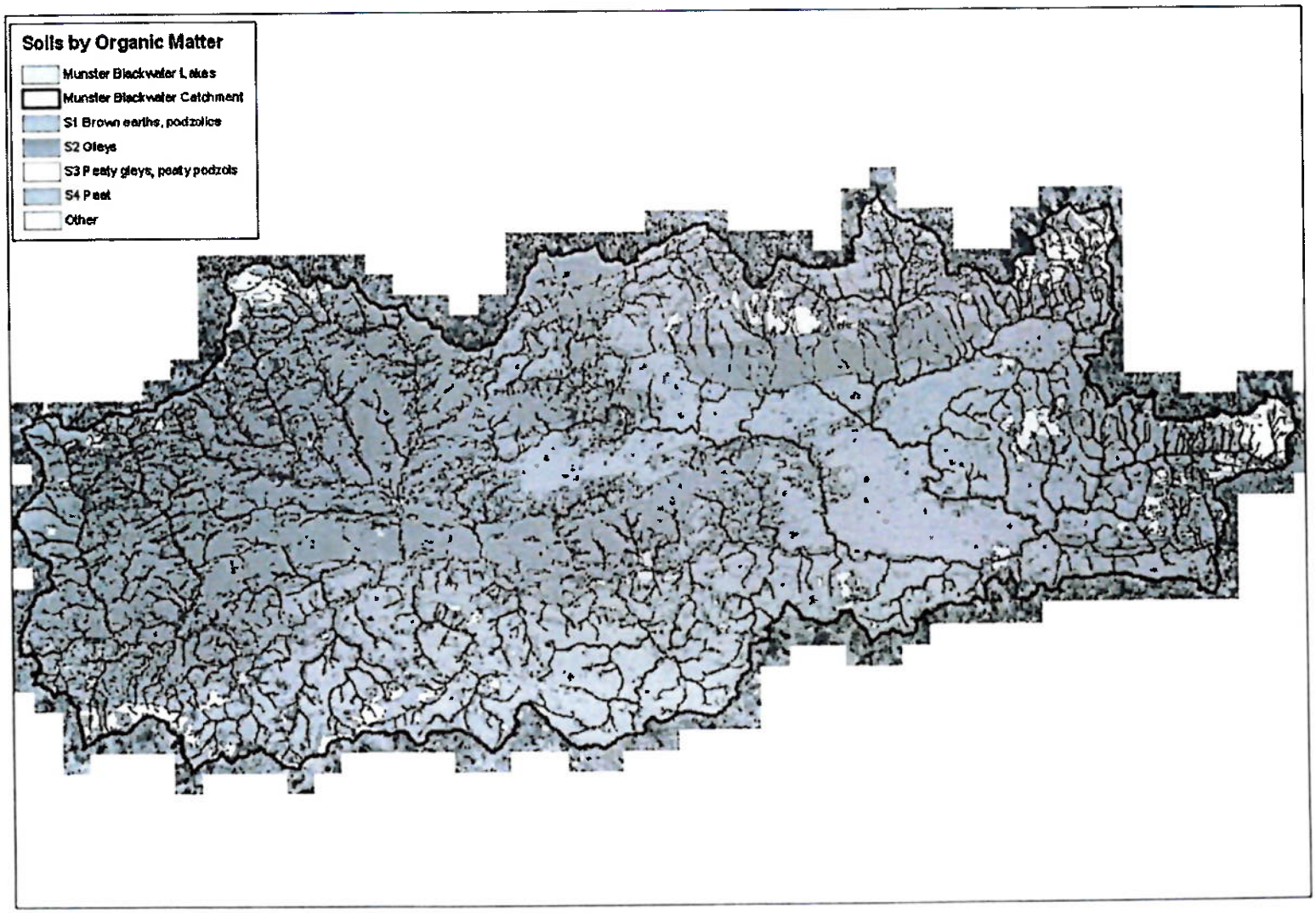

Figure 2.6: Soils by organic matter in the Munster Blackwater and Allow Catchment (from DEHLG, 2010)

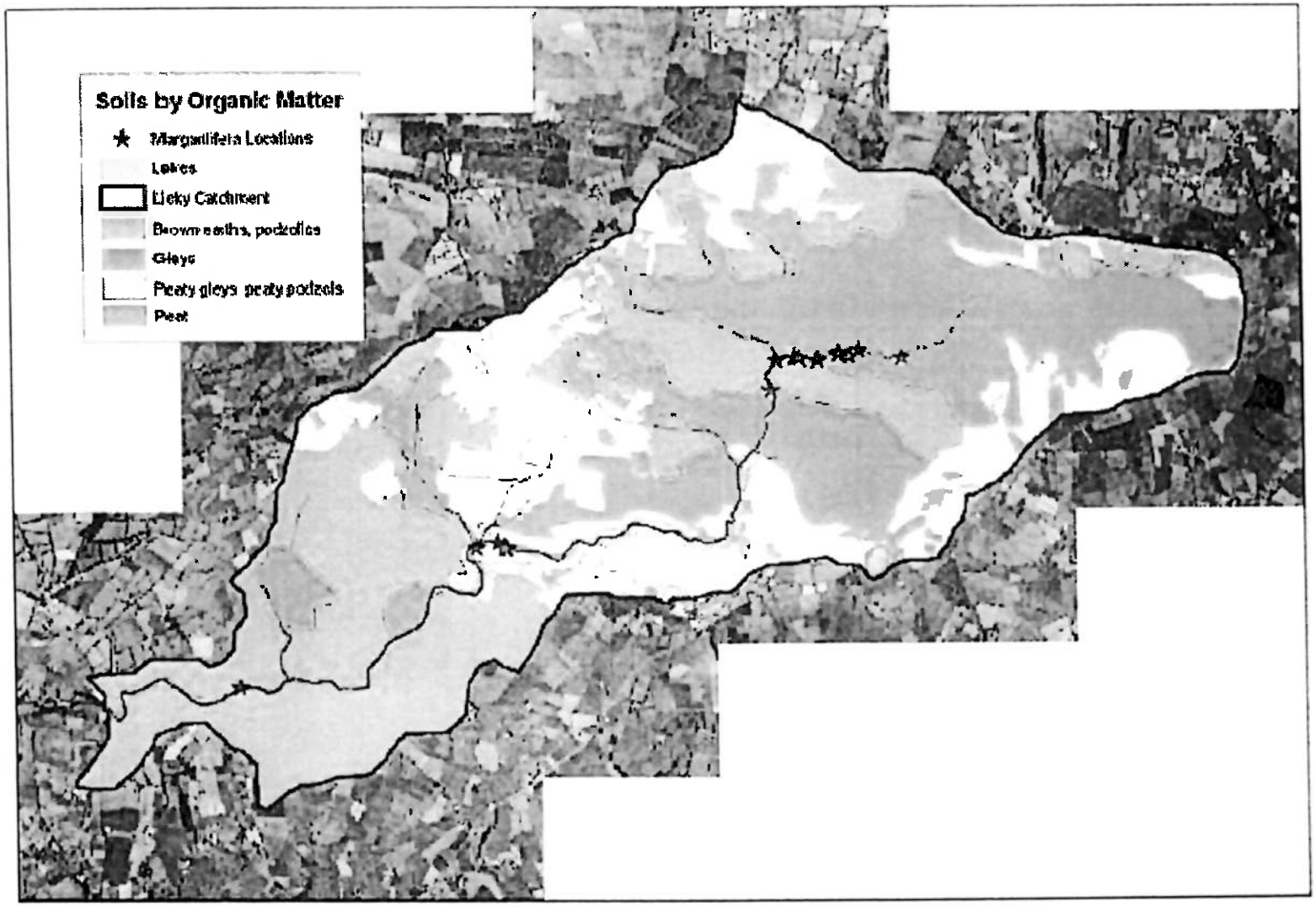

Figure 2.7: Soils by organic matter in the Lickey Catchment (from DEHLG, 2010b)

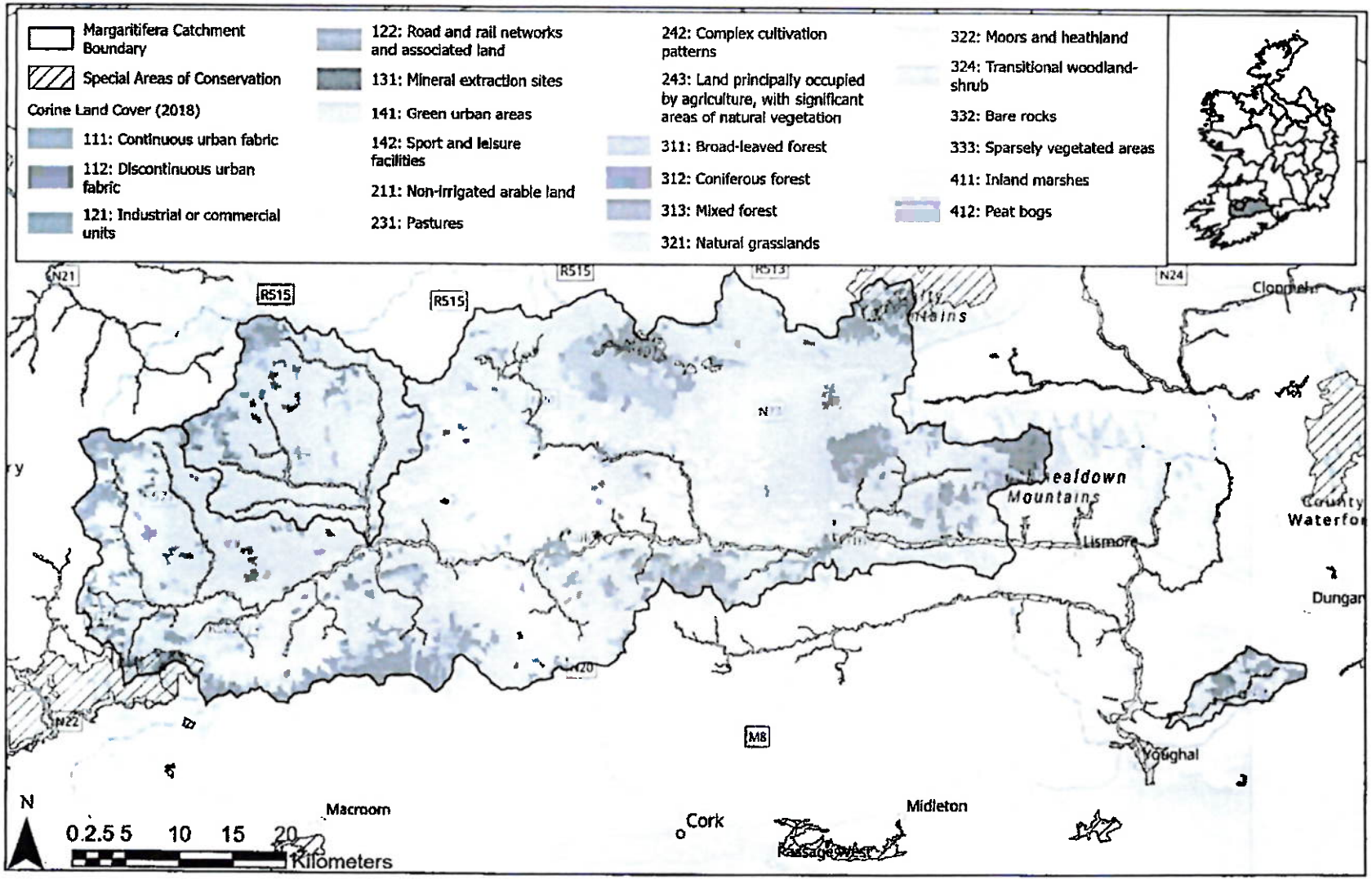

Figure 2.8: CORINE habitats in the sub basins of the three Margaritifera populations in the Blackwater River (Cork/Waterford) SAC (002170)

Flashy flow in the peat and poorly draining areas of the SAC leads to a dominance of coarse (alluvial) sediments in watercourses hosting a range of habitat types over short distances. By contrast, sustained rates of streamflow during drier periods help to remove finer grained and less dense deposits.

The conceptual model of the physical characteristics of intact high-status catchments in a poorly drained catchment is presented in Figure 2.9. These are the types of physical conditions required to assist in the restoration of favourable conservation status for the *Margaritifera* population. These conditions occur in the upper north-west portion of the Munster Blackwater catchment, the upper reaches of the Licky catchment and the vast majority of the entire Allow catchment. In these parts of the catchments *Margaritifera* populations are supported by catchment wetness with greater potential to provide suitable habitat for the species. The protection/restoration of hydrology within these parts of the catchment is of critical importance.

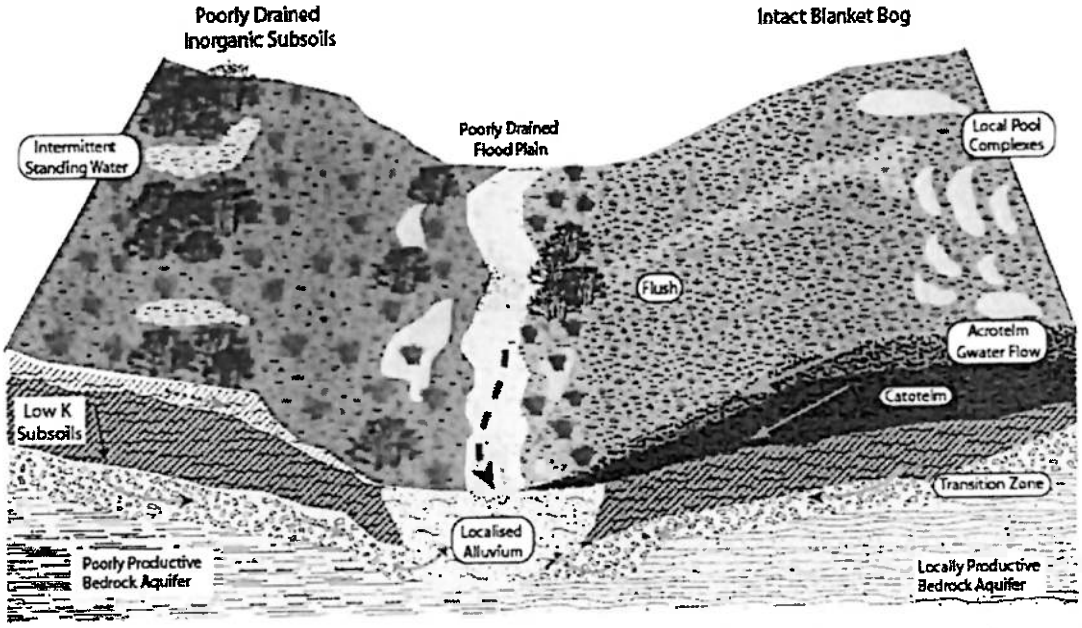

Figure 2.9: Conceptual model of intact catchment characteristics in the Upper Munster Blackwater (Waters of Life, 2023)

2.2.2 Well drained mineral lowland catchment

The occurrence of significant thicknesses of permeable subsoils, even when underlain by poorly productive and locally productive bedrock can give rise to free draining conditions and low water tables, e.g., across the south and east of the Munster Blackwater catchment and lower reaches of the Licky catchment. Under these circumstances, the delivery of particulates, particulate-associated solutes and dissolved phosphorus reduces considerably as ground conditions promote the infiltration of water. This process fosters attenuation as a result of greater opportunities for interactions between contaminants and geological materials, including through filtration, adsorption and precipitation.

Where soil/ subsoil sequences prove thin, the hydrogeological properties of bedrock prove more critical, with reduced to no attenuation occurring in the overburden. For most Irish bedrock units, transport of groundwater contaminants occurs via fissures (natural fractures in rock), whose frequency typically decline exponentially with depth. This decline is accompanied by a reduction in hydraulic conductivity (the ability to transmit water) with depth. This leads to groundwater flow occurring predominantly in the uppermost parts of the bedrock and the overlying (physically) weathered subsoil horizons; these units are collectively referred to as the Transition Zone (Figure 2.10).

Karst conditions, which occur widely in Irish clean limestone aquifers, contrast with those encountered in other bedrock units. The action of naturally acidic water flowing through the fissures in soluble carbonate rock results in them widening over time, and allows water to flow more rapidly through them. The sustained and often focused dissolution experienced by karst bedrock can lead to the development of landscapes

containing karst features, particularly in the absence of significant sequences of overburden. These features include swallow holes, which focus the flow of water entering aquifers (recharge), and karst springs, whose discharge and water quality can vary substantially over short spaces of time (See Figure 2.10 taken from Waters of Life, 2023).

Karst features allow water borne contaminants, including particulates, to reach the water table while experiencing little to no attenuation. Moreover, wide-fissured (conduit) systems, typically connected to these features, further facilitate the rapid transport of contaminants with little to no attenuation and can result in rapid delivery of contaminants to springs and watercourses in time frames comparable to those typically encountered in shallower hydrological pathways. Overall, attenuation can prove limited, but can be enhanced where karst features are overlain by appreciable thicknesses of soils (Figure 2.10).

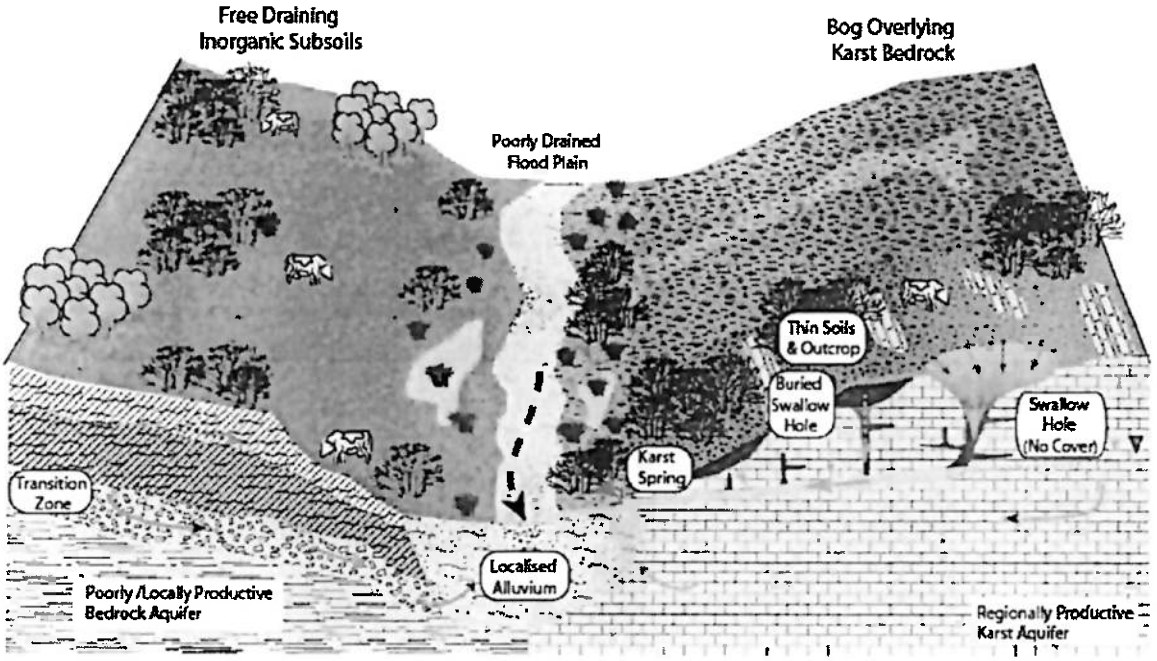

Figure 2.10: Schematic illustration of hydrological conditions operating in an undisturbed freely draining conditions in a near-natural setting (Waters of Life, 2023).

The left side of Figure 2.10 illustrates the parts of the catchment underlain by significant sequences of freely draining subsoils with groundwater discharging to a stream flowing through a locally waterlogged alluvial plain. Illustrated on the right is the parts of the catchment underlain by karstified limestone. Thin soils and karst landscape features, such as swallow holes can allow water to rapidly reach the water table which coincides with the areas of extreme vulnerability as illustrated in Figure 2.4. Where thicker low permeability subsoil sequences occur, the influence of the underlying bedrock reduces considerably, and in areas of high and frequent effective rainfall this can give rise to development of bogs (Waters of Life, 2023).

The above descriptions aim to present conditions across the Munster Blackwater, Allow and Licky catchments where free draining conditions are prevalent. However, this is rarely the case, where drainage conditions prove heterogeneous, and where drainage conditions can change over short distances as a function of geology, topography and climate. Moreover, the drainage conditions typically form part of a continuum, with the transition from poorly draining to freer draining proving gradual, while the installation of features such as artificial drainage further complicates hydrological processes.

In these sections of the catchments where there are mineral/well-draining soils, preferential *Margaritifera* habitat is dictated by local scale hydromorphology and a functional river flood plain. Suitable habitat will therefore be patchier in its distribution. In areas with suitable habitat, sediment and nutrient retention within a functional river floodplain is important for the protection and restoration of *Margaritifera*.

2.3 Distributions and designations

2.3.1 Munster Blackwater Population

There have been a number of baseline surveys undertaken in the Munster Blackwater and Owentaraglin, but given the very long length of the potential mussel habitat these have covered only a very small area of the river. Much of the survey coverage comes from planning application assessment investigations.

The Munster Blackwater has not featured in the 3-year cycle of *Margaritifera* SAC monitoring between 2010 and 2021.

The results from all the various presence/absence and total counts surveys show that the Munster Blackwater has a scattered population of mussels over a very wide area from upstream Knocknagree to as far downstream as Lismore (unpublished NPWS monitoring data). However, given the size of the river, the numbers of individuals recorded is very low. Only two sections have moderate numbers recorded, in the main channel downstream of the Finnow confluence where c. 1500 were found in 2015 and more recently in the Owentaraglin between Cullen Bridge and the Blackwater confluence where 1634 mussels were found in 2019/20.

The distribution and abundance of freshwater pearl mussels in the Munster Blackwater catchment is poorly known. The current population size is estimated as 5000 – 10,000 individuals including the Owentaraglin where nearly 2000 mussels were found in 2020. It is believed that much of the rest of the population is found between the Owentaraglin and Allow confluences (unpublished NPWS monitoring data).

The lower Owentaraglin and the main channel between the Owentaraglin and Allow confluences supports good physical juvenile habitat, the structure of the river bed is such that it could support sustainable amounts of juvenile mussels if the condition of the river improves. However, the population is declining through the lack of juvenile survival, and this situation must be remedied if the population is to avoid extinction.

Figure 2.11 illustrates the known *Margaritifera* habitat that has been mapped in the Munster Blackwater catchment, as presented in the Site-Specific Conservation Objectives (NPWS, 2012). It is important to remember that this map provides the known location of the suitable habitat, and the project proponent should satisfy themselves that *Margaritifera* populations and habitat will not be impacted by their proposed plan or development.

2.3.2 Allow Population

The Allow population distribution is well known, with a good baseline of 23km of river surveyed by the Duhallow LIFE project between 2012 and 2016 (IRD Duhallow, 2016). More recent updates come from monitoring studies to assess condition assessment of the population.

The population size of *Margaritifera* in the Allow in 2020 was estimated at approximately 17,600 individuals based upon IRD Duhallow results from 2016, although it is likely to have declined in the intervening 7 years (unpublished NPWS monitoring data). Mussel density in some parts of the river was classified as Common (>300 in a 100m section), in contrast to many depleted populations where residual mussels can end up in pools or under trees close to the river banks.

Although the Allow supports good physical juvenile habitat in places, the population is declining through lack of juvenile survival. The 2016 condition assessment showed that mussels were highly stressed despite good conditions in the riverbed. This is indicative of potentially regular nutrient, sediment or sub-lethal toxic pollution. The Allow population has failed condition assessment for juvenile recruitment and macrophyte growth (unpublished NPWS monitoring data).

Figure 2.11illustrates the known *Margaritifera* habitat that has been mapped in the Allow catchment, as presented in the Site-Specific Conservation Objectives (NPWS, 2012). It is important to remember that this map provides the known location of the suitable habitat and the project proponent should satisfy themselves that *Margaritifera* populations and habitat will not be impacted by their proposed plan or development.

2.3.3 Licky Population

The Licky population has had a detailed baseline study (Ross, 2003, 2005). More recent updates come from monitoring studies to assess condition assessment of the population.

Surveys between 2010 and 2016 indicated that the Licky population was likely to comprise approximately 2000 individuals. An assessment of *Margaritifera* Site-Specific Conservation Objectives has revealed that the Licky population is failing to achieve all of the targets set.

Evidence of mussel kills was found each time the catchment was surveyed between 2010 and 2020 (5 occasions). This is a worrying trend and is likely to result in a much quicker extinction than has been estimated for the population (extinction by 2050) (unpublished NPWS monitoring data).

Figure 2.11 illustrates the known *Margaritifera* habitat that has been mapped in the Licky catchment, as presented in the Site-Specific Conservation Objectives (NPWS, 2012). It is important to remember that this map provides the known location of the suitable habitat and the project proponent should satisfy themselves that *Magartifera* populations and habitat will not be impacted by their proposed plan or development.

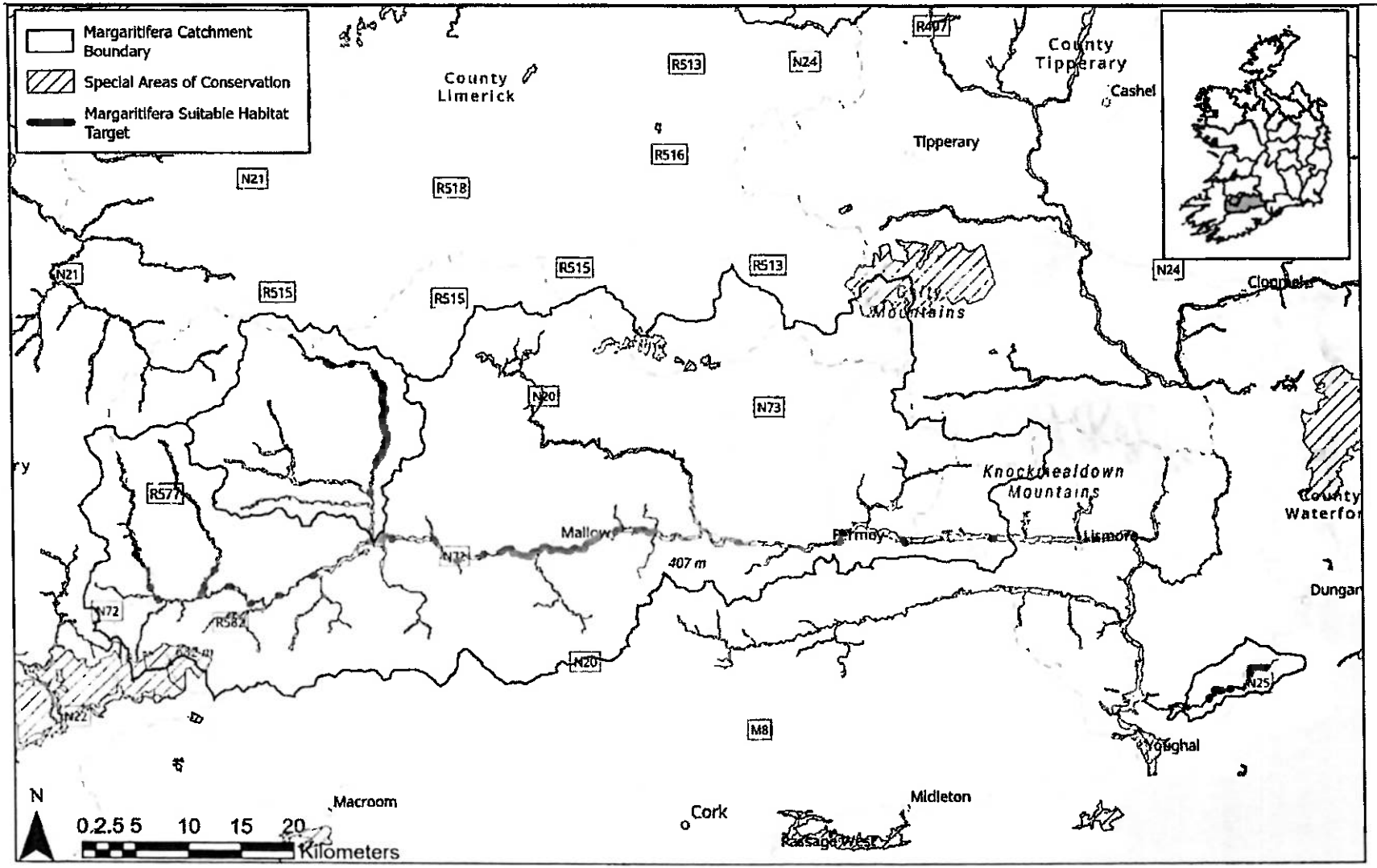

Figure 2.11: The known distribution of suitable *Margaritifera* habitat in the Blackwater River (Cork/Waterford) SAC (002170)

2.4 *Margaritifera* Requirements

A clear scientific understanding of the ecological requirements for a fully functioning *Margaritifera* population is needed. Section 1.4 of the main guidance document provides detail on the requirements needed to ensure the objective of maintain or restoration of favourable conservation status for the species is achieved.

2.5 Causes of decline

Margaritifera is extremely sensitive to changes in its environment, and the species is subject to a wide range of pressures which can act alone or in-combination with other pressures to negatively affect populations (NPWS, 2019). In general, any activities or projects within the catchment which result in changes to the natural processes or functioning of the river system are likely to have a negative effect on *Margaritifera* populations. The main broad issues causing declines in *Margaritifera* populations include:

- Habitat deterioration arising from changes in water quality and hydromorphology (the flow and physical character of the river)
- Changes to catchment hydrology
- Nutrient enrichment
- Sedimentation of river substrate

These issues can arise from a broad range of pressures such as wastewater treatment plants and septic tanks, industrial discharges, land drainage, forestry, agricultural intensification, development (roads, flood relief, housing etc.). Figure 2.12 below shows a schematic describing the various catchment level activities and pressures affecting *Margaritifera*, the impact of these activities on processes within the river system, the effects of the changes in river processes on *Margaritifera* populations and habitat requirements, and the eventual outcome for *Margaritifera* populations.

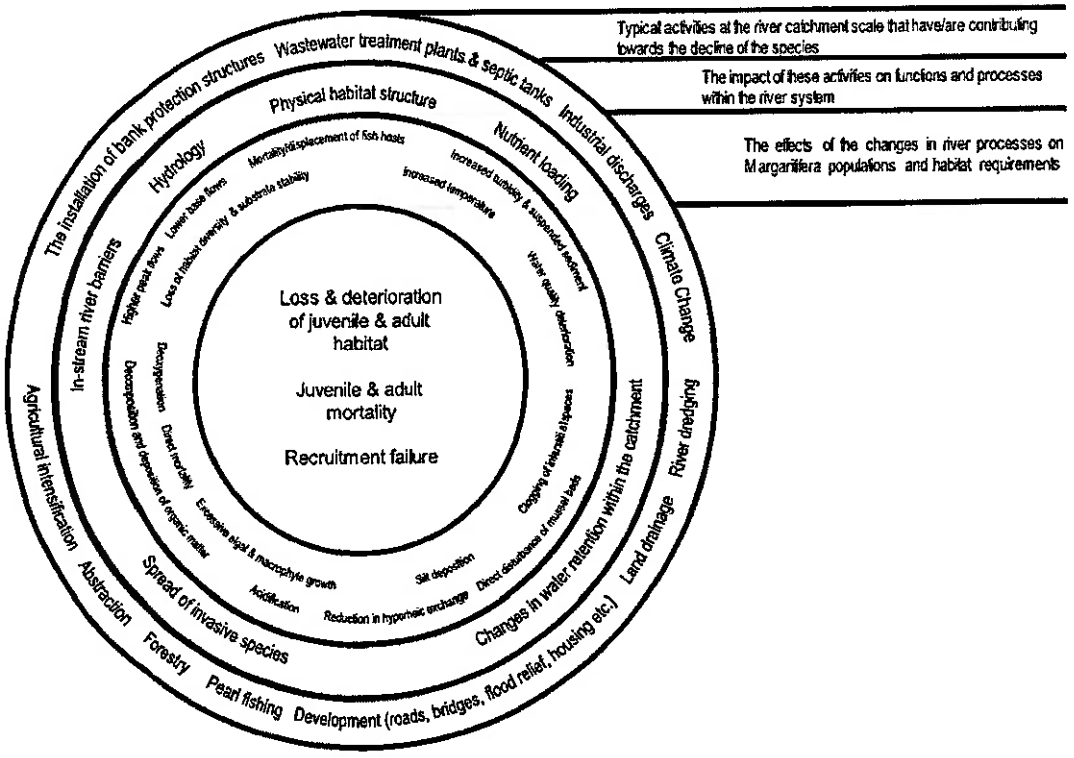

Figure 2.12. Causes of *Margaritifera* decline. The schematic shows (from the outer ring to the centre) the typical activities at the river catchment scale that have/are contributing towards the decline of the species, the impact of these activities on processes within the river system, the effects of the changes in river processes on *Margaritifera* populations and habitat requirements, and the eventual outcome for *Margaritifera* populations. Based on various sources namely NASI (2017), NPWS (2019), Moorkens & Killeen (2014).

Given its large size, the Munster Blackwater is subject to a wide range of pressures including agriculture, forestry, housing and urbanisation, industry, drainage, flood protection, quarries, water abstraction, waste water and pollution from a range of sources (NPWS, 2023a). According to the 'Morphological Monitoring and Catchment Walkover Risk Assessment' report prepared for the Munster Blackwater as part of the NS 2 *Margaritifera* sub-basin management plan, intensive agriculture or intensively managed lands pose the most significant impacts to *Margaritifera* habitat (DEHLG, 2010). More recent data on the status of *Margaritifera* and monitoring in the Munster Blackwater catchment (unpublished NPWS monitoring data) also highlights agricultural drainage and intensification as posing the greatest direct threat to the river in addition to the high density of on-site septic tank systems.

The Allow is also subject to a wide range of pressures including agriculture, forestry, housing and urbanisation, industry, drainage, flood protection, quarries, water abstraction, waste water and pollution from a range of sources. The greatest direct threat to the river comes from agricultural drainage and intensification (unpublished NPWS monitoring data).

The Licky catchment has been severely impacted by catchment level drainage for forestry and agriculture. These are the 2 most dominant land use types in the catchment. This has resulted in major hydrogeological changes as well as high sedimentation risk from direct drainage pathways into the river (unpublished NPWS monitoring data).

Pressures and threats in the Munster Blackwater, Allow and Licky catchments, reproduced from Moorkens (in prep.) are outlined in Table 2-1.

Table 2-1: Pressures and threats in the Munster Blackwater, Allow and Licky catchments. Reproduced from Moorkens (in prep.).

Pressure & Threat in Article 17 Report	Severity in Munster Blackwater Catchment	Severity in the Allow Catchment	Severity in the Licky Catchment
PA17 Agricultural activities generating diffuse pollution to surface or ground waters (H) Formerly A25, A26, A28 (merged) – A25: Agricultural activities generating point source pollution to surface or ground waters - A26: Agricultural activities generating diffuse pollution to surface or ground waters – A28: Agricultural activities generating marine pollution also includes prior pressure -A24 (Waste management practices in agriculture)	Severe	Severe	Severe
PA22 (formerly A31) Drainage for use as agricultural land (H)	Severe	Severe	Severe
PB19 (formerly B23 & B25 merged) Forestry activities generating pollution to surface or ground waters (H)	Severe	Severe	Severe
PB23 (formerly B27) Modification of hydrological conditions, or physical alteration of water bodies and drainage for forestry (including dams) (H)	Severe	Severe	Severe
PC05 (formerly C05) Peat extraction (M)	Local scale	Severe	Local scale
PD02 (formerly D02) Hydropower (dams, weirs, run---off---the---river), including infrastructure (M)	Five significant fords are present in the Owentaraglin, Araglin and Funshion Rivers and in the Munster Blackwater at	Low	Major pollution damage at Carrigeen Ford and Reanagullee

Pressure & Threat in Article 17 Report	Severity in Munster Blackwater Catchment	Severity in the Allow Catchment	Severity in the Licky Catchment
	Farnankeel Bridge and Ballyhooley.		
PF07 Residential and commercial activities and structures generating pollution to surface or ground waters (M) Formerly F11, F12, F14, F16 (merged) – F11: Pollution to surface or ground water due to urban run-offs - F12: Discharge of urban waste water (excluding storm overflows and/or urban run-offs) generating pollution to surface or ground water - F14: Other residential and recreational activities and structures generating point pollution to surface or ground waters - F16: Other residential and recreational activities and structures generating diffuse pollution to surface or ground waters	There are 18 major WWTP's in the Munster Blackwater and all should be reviewed again. A number of quarries operate, the largest being Roadstone Quarry at Lacknamona, Mallow. A further 18 quarries are registered in the catchment. Diffuse pollution from on-site WWTP's is high risk due to very high numbers and poor absorption on peaty land	Severe from point sources. Risk areas are Newmarket Co-Op and Kanturk Creamery, Kanturk Mart, Meelin and Boherbue septic tanks.	Smaller WWTP's should be reviewed
PF14 (formerly F28) Modification of flooding regimes, flood protection for residential or recreational development (M)	Increasing risk	Future threat	Increasing risk
PF17 Active abstraction of water for built-up areas (H) Formerly F31, F32, F33, F34 (merged) - F31: Other modification of hydrological conditions for residential or recreational development - F32: Other modification of hydrological conditions for industrial or commercial development - F33: Abstraction of ground and surface waters (including marine) for public water supply and recreational use - F34: Abstraction of ground and surface waters (including marine) for commercial/industrial use (excluding energy)	Abstraction from the Licky River is not documented	Severe, Allow Regional Supply at Freemount	Abstraction from the Licky River is not documented
Additional threats and pressures with relevance to Munster Blackwater, Allow and Licky			
PA01 (formerly A01) Conversion into agricultural land (excluding drainage and burning)	Severe	Severe	Severe
PA20 Livestock farming generating pollution (new pressure)	Severe	Severe	Severe
PB01 (formerly B01) Conversion to forest from other land uses, or afforestation (excluding drainage)	Severe threat from forest plans	Severe threat from forest plans	Severe threat from forest plans
PB24 Drainage for forestry (new pressure)	Severe threat from forest plans	Severe threat from forest plans	Severe threat from forest plans

Pressure & Threat in Article 17 Report	Severity in Munster Blackwater Catchment	Severity in the Allow Catchment	Severity in the Licky Catchment
PC01 (formerly C01) Extraction of minerals (e.g. rock, metal ores, gravel, sand, shell)	Low	Low	Low
PD01 (formerly D01) Wind, wave and tidal power, including infrastructure	Low	Low	Low
PJ01 Temperature changes and extremes due to climate change and **PJ03** Changes in precipitation regimes due to climate change	Ongoing threat and rising pressure	Ongoing threat and rising pressure	Ongoing threat and rising pressure

2.6 Protection under Irish and EU legislation

Margaritifera is protected under both Irish and EU legislation. Key legislation aimed at protecting *Margaritifera* is listed below:

- The Wildlife Acts (1976-2023) – this is the most important national legislation providing for the protection of wildlife in Ireland.
- European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations, S.I. 296 of 2009) – outlines legally binding environmental objectives for *Margaritifera* in Ireland. It is important to note that S.I. 355 of 2018 the European Union Environmental Objectives (Freshwater Pearl Mussel) (Amendment) Regulations 2018 were quashed in 2019 following judicial review proceedings, and therefore *Margaritifera* remains a qualifying interest in the Munster Blackwater SAC as per S.I. 296 of 2009.
- Habitats Directive – *Margaritifera* is listed under Annex II and Annex V of the Directive. 19 SACs have been designated for the protection of *Margaritifera* in Ireland. In the Munster Blackwater, Allow and Licky catchments, *Margaritifera* are protected as part of the Blackwater River (Cork/Waterford) SAC (002170).
- Water Framework Directive (WFD) – Aims to protect and improve water quality in all waters so that at least "good ecological status" is achieved by 2027. Any European Site with listed water-dependent habitats or species and, where that protected area has been designated due to the presence of those species or habitats, has to be considered for the register of protected areas under WFD Article 6 (European Commission, 2011).

Further detail on the protection of *Margaritifera* under Irish and EU legislation is available in the overall guidance document for *Margaritifera*.

3 LEGLISATION FOR THE PROTECTION OF MARGARITIFERA IN THE BLACKWATER RIVER (CORK/ WATERFORD) SAC

3.1 The Wildlife Act

All *Margaritifera* populations within the Munster Blackwater, Allow and Licky catchments are protected under the Wildlife Acts (1976-2023). It is an offence to injure or wilfully interfere with or destroy the breeding place or resting place of *Margaritifera*.

3.2 Protection under the Habitat's Directive

The Habitats Directive provides legal protection for habitats and species of European importance. Under Article 6(1) of the Habitats Directive, Member States are required to establish the necessary conservation measures to maintain or restore the habitats and species for which the site has been designated to a favourable conservation status. Under Article 6(2) of the Habitats Directive, Member States are required to avoid damaging activities that could result in significant disturbance of listed species and their habitats and deterioration of listed habitats. Article 6(3) and (4) set out a series of procedural and substantive safeguards governing plans and projects likely to have a significant effect on a designated site.

The Habitats Directive affords protection to all *Margaritifera* populations within the Blackwater River (Cork/Waterford) SAC (002170).

However, *Margaritifera* populations outside the boundaries of the Blackwater River (Cork/Waterford) SAC (002170) are also protected under the Habitats Directive, provided they serve a role in maintaining the conservation objectives of the *Margaritifera* populations within the SAC. This has been established in case law, namely Holohan and Others v An Bord Pleanála (C-461/17)[2]. The court ruled "*Article 6(3) of the Habitats Directive must be interpreted as meaning that an 'appropriate assessment' must, on the one hand, catalogue the entirety of habitat types and species for which a site is protected, and, on the other, identify and examine both the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect the conservation objectives of the site.*"

It is important to note that *Margaritifera* populations and their host fish outside the boundaries of the Blackwater River (Cork/Waterford) SAC are protected under Article 6(2) of the Habitats Directive and the implications for them must also be examined under Article 6(3) if those implications are liable to affect the conservation objectives of the SAC.

3.3 European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (S.I. No. 296)

Under Article 6 of the Habitats Directive Member States must show the steps taken to achieve the Directives objectives as well as avoiding deterioration in those natural habitats and habitats of Annex II species. To assist in the achievement these requirements in Ireland, the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (S.I. No. 296) (hereafter referred to as "the 2009 Regulations") have been established.

The 2009 Regulations set environmental quality objectives for the habitats of the freshwater pearl mussel SAC populations. The 2009 Regulations require the production of sub-basin management plans with programmes of measures to achieve these objectives and set out the duties of public authorities in respect of

[2] https://curia.europa.eu/juris/document/document.jsf?text=&docid=207428&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=254381

the sub-basin management plans and programmes of measures. These plans must be reviewed and revised every 6 years to incorporate new scientific evidence and new national policies and pressures.

A sub-basin management plan was prepared for each of the Munster Blackwater, Allow and Licky catchments in 2009/2010. These sub-basin management plans were produced to provide a programme of measures required to improve the habitat of *Margaritifera* so that the populations can attain favourable conservation status. The plans set out the pressures identified in each catchment, the status of the *Margaritifera* population, monitoring requirements, a list of site and catchment-specific measures that are prioritised for the catchment over the timescale of the plan as well as measures to be taken across the wider river basin district. Note, however, that these plans, as well as the other sub-basin plans in Ireland, were prepared as part of the 1st cycle of River Basin Management Plans for 2009-2015. They have not been published as per the legal requirement of the regulations, or updated as part of the 2nd or 3rd cycles, resulting in gaps where more detailed requirements now known for *Margaritifera* should be updated.

Refer to the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments" for further detail on the 2009 Regulations.

3.4 The Specific conservation objectives for the Blackwater River (Cork/ Waterford) SAC (site code 002170)

The conservation objectives for each *Margaritifera* SAC population have been developed and provide the attributes and targets that define whether *Margaritifera* populations are in favourable condition. Specific conservation objectives were prepared for the Blackwater River (Cork/ Waterford) SAC in 2012 (NPWS, 2012). The conservation objectives for *Margaritifera* in the Blackwater River (Cork/ Waterford) SAC are outlined in Table 3-1. Importantly, the conservation objective for *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002170) is to "restore" the favourable conservation condition of the species.

The *Margaritifera* population is at unfavourable conservation status in the Blackwater River (Cork/Waterford) SAC (002170).

Table 3-1: Site-Specific Conservation Objectives for *Margaritifera* in the Blackwater River (Cork/ Waterford) SAC which should form the basis for assessment for projects that could impact the *Margaritifera* populations within this SAC. The table is extracted directly from the Conservation Objectives (CO) Document for the Blackwater River (Cork/Waterford) SAC (002170)[3] and should be read in conjunction with the maps etc. provided in the CO document.

Conservation Objective	Measure	Target	Notes
Distribution	Kilometres	Maintain at 161km	The freshwater pearl mussel is known from the main Blackwater River, two tributaries (Owentaraglin and Allow) and the Licky River, which discharges to the Upper Blackwater Estuary. 168km encompasses the length of channel from the most upstream records of the freshwater pearl mussel to the most downstream records of live mussels, and contained within the freshwater pearl mussel catchment boundaries displayed on map 8.
Population Size	Number of Adult Mussels	Restore to 35,000 adult mussels	The SAC has three populations listed on the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations of 2009 (S.I. 296 of 2009): Munster Blackwater, Allow (Munster Blackwater) and Licky. The separation of the main channel Blackwater and Allow into two populations is artificial and no longer considered appropriate. The Licky, however, is a distinct population, being separated from the Blackwater by brackish water and a hydrological distance of approx. 30km, making genetic exchange very unlikely. Information on the size of the population in the Blackwater and its tributaries is poor, but estimated at less than 10,000 for the Blackwater main channel (target set at 10,000); and between 10,000 and 20,000 for the Allow tributary (target set at 15,000) (DEHLG, 2010a, 2010b). The Licky population

[3] https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002170.pdf

Conservation Objective	Measure	Target	Notes
			was estimated as just greater than 10,000 in 2005, but was estimated to have declined to approx. 4,700 by 2009 (target set at 10,000) (Ross, 2005; DEHLG, 2010c).
Population Structure: Recruitment	Percentage per size class	Restore to least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length	Mussels of no more than 65mm are considered 'young mussels' and may be found buried in the substratum and/or beneath adult mussels. Mussels of no more than 30mm are 'juvenile mussels' and are always buried in the substratum. The Blackwater population is believed to be composed entirely of aged adults, with no evidence of recruitment for at least 20 years (DEHLG, 2010a). No juvenile mussels were found in the Allow and 8.3% of the population was no more than 65mm in length in 2009 (DEHLG, 2010b). No young or juvenile mussels were recorded in the Licky during monitoring in 2005 or 2009 and there was no evidence that recruitment had occurred in at least 12 years, with the smallest mussel in 2009 measuring 85.3mm (Ross, 2005; DEHLG 2010c)
Population Structure: adult mortality	Percentage	No more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution	5% is considered the cut-off between the combined errors associated with natural fluctuations and sampling methods and evidence of true population decline. 1% of dead shells is considered to be indicative of natural losses. The Allow passed the target for live adults, but failed that for dead shells in 2009 (DEHLG, 2010b). The Blackwater and Licky failed both targets in 2009 (DEHLG, 2010a, 2010c).
Habitat Extent	Kilometres	Restore suitable habitat in more than 35km (see map 8) and any additional stretches necessary for salmonid spawning	The species' habitat covers stretches of very large, high energy, lowland rivers (Blackwater) and a short coastal river (Licky); and is a combination of 1) the area of habitat adult and juvenile mussels can occupy and 2) the area of spawning and nursery habitats the host fish can occupy. Fish nursery habitat typically overlaps with mussel habitat. Fish spawning habitat is generally adjacent to mussel habitat, but may lie upstream of the generalised mussel distribution. Only those salmonid spawning areas that could regularly contribute juvenile fish to the areas occupied by adult mussels should be considered. The availability of mussel habitat and fish spawning and nursery habitats are determined by flow and substratum conditions. The habitat for the species is currently unsuitable for the survival of adult mussels or the recruitment of juveniles. The target is based on the stretches of river identified, from a combination of dedicated survey and incidental records, as having suitable habitat for the species. As there has been no full baseline survey, the quality of the data from the Blackwater and its tributaries is poor.
Water Quality: Macroinvertebrate and phytobenthos (diatoms)	ecological quality ratio (EQR)	Restore water quality- macroinvertebrates: EQR greater than 0.90; phytobenthos: EQR greater than 0.93	These EQRs correspond to high ecological status for these two Water Framework Directive biological quality elements. They represent high water quality with very low nutrient concentrations (oligotrophic conditions). The habitat in the Blackwater and Licky failed both standards during 2009 sampling for the Sub-basin Management Plans, while the Allow failed the macroinvertebrate target (DEHLG, 2010a, 2010b, 2010c). See also The European Communities Environmental Objectives (Surface Water Objectives) Regulations 2009 (Government of Ireland, 2009a).
Substratum quality: filamentous algae (macroalgae), macrophytes (rooted higher plants)	Percentage	Restore substratum quality- filamentous algae: absent or trace (<5%)	Significant growth of macrophytes was found at some sites in all three populations sampled during 2009 for the Sub-basin Management Plans (DEHLG, 2010a, 2010b, 2010c). Filamentous algae were below the target at all sites sampled in the Allow, however significant growths were detected at some sampling sites in the Blackwater and Licky (DEHLG, 2010a, 2010b, 2010c). Recruitment of juvenile mussels is being prevented by the poor quality of the river substrate.

Conservation Objective	Measure	Target	Notes
Substratum Quality: Sediment	Occurrence	Restore substratum quality- stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment	The habitat for the species is currently unsuitable for the recruitment of juveniles owing to sedimentation of the substratum. In some locations, it is also unsuitable for the survival of adult mussels, notably stretches of the Licky (DEHLG, 2010c). Significant sedimentation has been recorded during all recent mussel monitoring surveys, particularly in the Licky and Allow (DEHLG, 2010a, 2010b, 2010c). Recruitment of juvenile mussels is being prevented by the poor quality of the river substrate.
Substratum Quality Oxygen availability	Redox potential	Restore to no more than 20% decline from water column to 5cm depth in substrate	Differences in redox potential between the water column and the substrate correlate with differences in oxygen levels. Juvenile mussels require full oxygenation while buried in gravel. In suitable habitat, there should be very little loss of redox potential between the water column and underlying gravels. Redox potential data are currently only available from the Allow, where loss in 2009 was 31.5 - 44.1% at 5cm depth (DEHLG, 2010b).
Hydrological Regime: Flow variability	Metres per second	Restore appropriate hydrological regimes	The availability of suitable freshwater pearl mussel habitat is largely determined by flow (catchment geology being the other important factor). In order to restore the habitat for the species, flow variability over the annual cycle must be such that: 1) high flows can wash fine sediments from the substratum, 2) low flows do not exacerbate the deposition of fines and 3) low flows do not cause stress to mussels in terms of exposure, water temperatures, food availability or aspects of the reproductive cycle.
Host Fish	Number	Maintain sufficient juvenile salmonids to host glochidial larvae	Salmonid fish are host to the larval form of the freshwater pearl mussel and, thus, they are essential to the completion of the life cycle. 0+ and 1+ fish are typically used, both because of the habitat overlaps and the development of immunity with age in the fish. Fish presence is considered sufficient, as higher densities and biomass of fish are indicative of enriched conditions in mussel rivers. Geist et al. (2006) found that higher densities of host fish coincided with eutrophication, poor substrate quality for pearl mussels and a lack of pearl mussel recruitment, while significantly lower densities and biomass of host fish were associated with high numbers of juvenile mussels. Fish movement patterns must be such that 0+ fish in the vicinity of the mussel habitat remain in the mussel habitat until their 1+ summer. No fish stocking should occur within the mussel habitat, nor any works that may change the salmonid balance or residency time. The Allow and Licky freshwater pearl mussel populations appear to favour native brown trout (Salmo trutta), therefore, it is particularly important that these are not out- competed by stocked fish (DEHLG, 2010b, 2010c). No data on fish preferences are available for the Blackwater.

3.5 Water Framework Directive (2000/60 EC)

The WFD is the most important piece of water legislation in Europe. The Directive requires all Member States to protect and improve water quality in all waters so that "good ecological status" is achieved by 2027. The WFD requires that Members States manage their waters on the basis of River Basin Districts (RBDs), and that River Basin Management Plans (RBMP) are prepared for each RBD. The RBMP must contain a programme of measures which outlines how the Directive's environmental objectives will be achieved in each RBD.

Under Article 6 of the WFD, Member States are required to "ensure the establishment of a register or registers of all areas lying within each river basin district which have been designated as requiring special protection under specific Community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly depending on water." As such, any European Site with water-dependent habitats or species and where that protected area has been designated due to the

presence of those species or habitats, has to be considered for the register of protected areas under WFD Article 6 (European Commission, 2011). These areas are referred to as "water-dependent Natura 2000 sites" and for these Natura 2000 sites, the objectives of the Birds Directive, Habitats Directive and WFD apply (European Commission, 2011). See section 1.6 for more detail.

The European Communities (Water Policy) Regulations as amended is the national legislation transposing the Water Framework Directive into Irish Law. The Regulations are the key legislative instrument for the implementation of the objectives of the WFD. Regulation 13 specifies that a river basin management plans may be supplemented by the production of additional detailed programmes and management plans for sub-basins to deal with particular aspects of water management that the relevant authorities consider appropriate. In Ireland draft sub basin plans have been created for all *Margaritifera* SAC catchments. Draft Sub Basin Management Plans for the Munster Blackwater, Allow and Licky catchments were produced in February and March 2010 to act alongside the wider River Basin Management Plans (RBMPs) produced in the first RBMP cycle to provide a programme of measures required to improve the habitat of *Margaritifera* in the three catchments so that it can attain favourable conservation status.

Projects affecting water bodies may also require assessment under the WFD and the Department for Housing, Local Government and Heritage (DHLGH) are currently preparing guidance on the level of assessment required to demonstrate a plan or project is compliance with the objectives of the WFD.

3.6 CEN Standard "Guidance standard on monitoring Fresh Water Pearl Mussel (*Margaritifera margaritifera*) populations and their environment" (CEN/TC 230/WG 21/TG 1/N157)

Details of the CEN Standard can be found in Section 2.2.3, page 12 of the main guidance document.

3.7 The Environmental Liability Directive (2004/35/EC)

Details of the Environmental Liability Directive can be found in Section 2.2.2, page 11 of the main guidance document.

3.8 Conservation measures implemented under article 6 (1) of the Habitats Directive

Article 6 outlines the provisions by which the conservation and management of Natura 2000 sites will be implemented. This is seen as one of the most important articles of the Directive as it governs the interaction between conservation and land-use (EC, 2000). In the context of *Margaritifera* it is critical to the measures that must be taken to restore or maintain 'favourable conservation status' of the SAC populations.

Article 6(1) makes provision for the establishment of the necessary conservation measures for an SAC. The measures are positive and apply to all annexed habitats and species. These can take the form of appropriate "Statutory, administrative or contractual measures or if deemed necessary an appropriate management plan."

The draft sub basin plans prepared for each *Margaritifera* SAC catchment, including the Munster Blackwater, Allow and Licky sub basin management plans, represent management plans applicable to one of the main qualifying features within the SAC. When adopted they will represent an important conservation measure that will be implemented to satisfy the objectives of Article 6(1). The plans will need to address all foreseen activities and unforeseen new activities including those requiring authorisation under Articles 6(3) and 6(4). The management plan will focus on the sub basin and provide a framework for the conservation measures and will assist in the determination of appropriate statutory, administrative and contractual measures.

3.9 Measures implemented to avoid interference and disturbance under Article 6(2) of the Habitats Directive

Article 6(2) makes provision for avoidance of habitat deterioration and significant species disturbance. Its emphasis is therefore preventive. It has a larger scope than Articles 6(3) and 6(4) which are limited to plans or projects that require authorizations. Article 6(2) applies to activities which do not necessarily require prior authorization, e.g., agriculture and forestry. This article requires Member States to take all reasonable measures to ensure that no deterioration of habitat or disturbance of species occurs.

Whilst the measures under this article only relate to habitats and species for which the European Site has been designated, these measures/actions can be required outside of the SAC to avoid deterioration of natural habitats and species within the SAC. This is particularly relevant to the sub-basin management plans and to this guidance document in that activities outside the SAC will require assessment of their potential effects and where necessary mitigation measures to achieve the conservation objectives for the Blackwater River (Cork/Waterford) SAC (002170).

4 THE CONSERVATION OBJECTIVES FOR THE BLACKWATER RIVER (CORK/WATERFORD) SAC (002170) POPULATION

4.1 Understanding the long-term objectives for the population and how they relate to the river and its catchment

The long-term objectives of the three *Margaritifera* populations within the Blackwater River (Cork/ Waterford) SAC are to restore favourable conservation condition. Favourable conservation condition will be achieved once the SSCO targets outlined in Table 3-1 are met.

As described in section 2.2, the Blackwater River (Cork/ Waterford) SAC can be broadly divided into a poorly drained peat catchment to its north and west, and a well-drained catchment to its south and east. There are a complex range of soil types present in the catchment. The bedrock aquifer is mixed with karstic influences across the centre of the catchment and is poorly productive with high vulnerability throughout.

Permanent *Margaritifera* habitat is predominantly determined by sufficiency of flow at the lower end of the flow duration curve (Moorkens and Killeen, 2014) and the presence of a clean and stable environment (Moorkens, 2020). As such, mussel habitats are not subject to regular infilling by fine sediment, followed by cleansing floods. Instead, their optimum habitat is likely to comprise a riverbed that is sufficiently stable to protect adults and juveniles from significant disturbance, but with water flowing fast enough to prevent the settlement of fine sediment entering the river, or fine organic sediment from decaying macrophytes or filamentous algae (Moorkens and Killeen, 2014). A continuous supply of fast flowing water during low summer flows is vital for a sustainable pearl mussel population. The hydrogeological context and soil drainage within a catchment influences river flows and can therefore influence the extent of suitable *Margaritifera* habitat.

Intact open peat habitats enhance the long-term hydrological resilience of a catchment by conserving water in the peat substrate (Kuemmerlen et al., 2021). As noted previously, in undisturbed peat areas, a significant proportion of dry weather flow derives from groundwater flowing directly from peat to watercourses, coupled with a lesser proportion from water travelling through peat and into the underlying inorganic substrate (Waters of Life, 2023). As a result, intact peatlands can release water to streams and rivers, which stabilises the watercourse by maintaining flow over prolonged periods (Waters of Life, 2023). Such hydrological regimes support *Margaritifera* by preventing the establishment of conditions that would negatively affect populations, in particular juvenile habitat (i.e., preventing the build-up of fine sediment and maintaining adequate oxygenation in interstitial spaces by sustaining relatively high velocities at relatively low flows). These hydrological regimes are widespread in undisturbed peat catchments which in turn allows *Margaritifera* to occupy a relatively large proportion of them (Moorkens, 2020). In poorly draining mineral soils, *Margaritifera* populations are supported by flows maintained by catchment wetness. Hydrological regimes in unimpacted poorly draining catchments have high potential to provide suitable habitat for the species.

In contrast, preferential flows for *Margaritifera* in well-draining mineral catchments are more naturally restricted in their spatial distribution (Moorkens, 2020). In intensively managed mineral catchments with well-draining soil, summer low flows are exacerbated by higher soil moisture deficits. Accordingly, wet conditions and fringing habitat in the floodplain (rush dominated wet grasslands) are critical to maintaining *Margaritifera* habitat in these parts of the catchment. In well-draining mineral catchments, flows supporting *Margaritifera* are maintained by a naturally functioning floodplain, specific local hydrogeological conditions (see section 2.2.2) and aspects of local scale hydromorphology. Most preferential flow habitat areas rely on an upstream and sometimes downstream flood zone that removes the scouring velocity potential of winter floods, as well as river slope, bend geometry, bends driven by bedrock outcrops or mid-channel islands which promote preferential *Margaritifera* flow down one limb during low flows (Moorkens, 2017).

The drainage and hydrogeological context of a *Margaritifera* catchment is important in determining *Margaritifera* distribution within the catchment. These baseline environmental characteristics can also influence the main pressure and threats to *Margaritifera*. For example, although tree planting is often recommended for restoring degraded river systems, in *Margaritifera* catchments with poorly draining open peat habitat, the maintenance of wet, open conditions is essential. In such catchments, the planting of trees is likely to affect the natural hydrological and hydrogeological regime (Flynn et al., 2022; Kuemmerlan et al, 2021) and as a result negatively affect *Margaritifera*. Therefore, in open peat *Margaritifera* catchments, trees

(native or otherwise) should not be planted in areas where they could result in impacts on the hydrological regime of a watercourse. In contrast to *Margaritifera* catchments within peat/poorly draining areas, in catchments with freely draining mineral soils, trees are less likely to influence the hydrological regime of rivers, and may therefore have a positive role in nutrient and sediment removal, on land where there is little potential for soil water storage. See section 7.5 below for further detail.

Nonetheless, in both poorly draining and well-draining areas of the Blackwater River (Cork/ Waterford) SAC, there are common drivers of *Margaritifera* habitat and population structure. For example, flood plain connectivity, hydrological regime, water quality, substratum quality and host fish are important in both contexts (Figure 4.1).

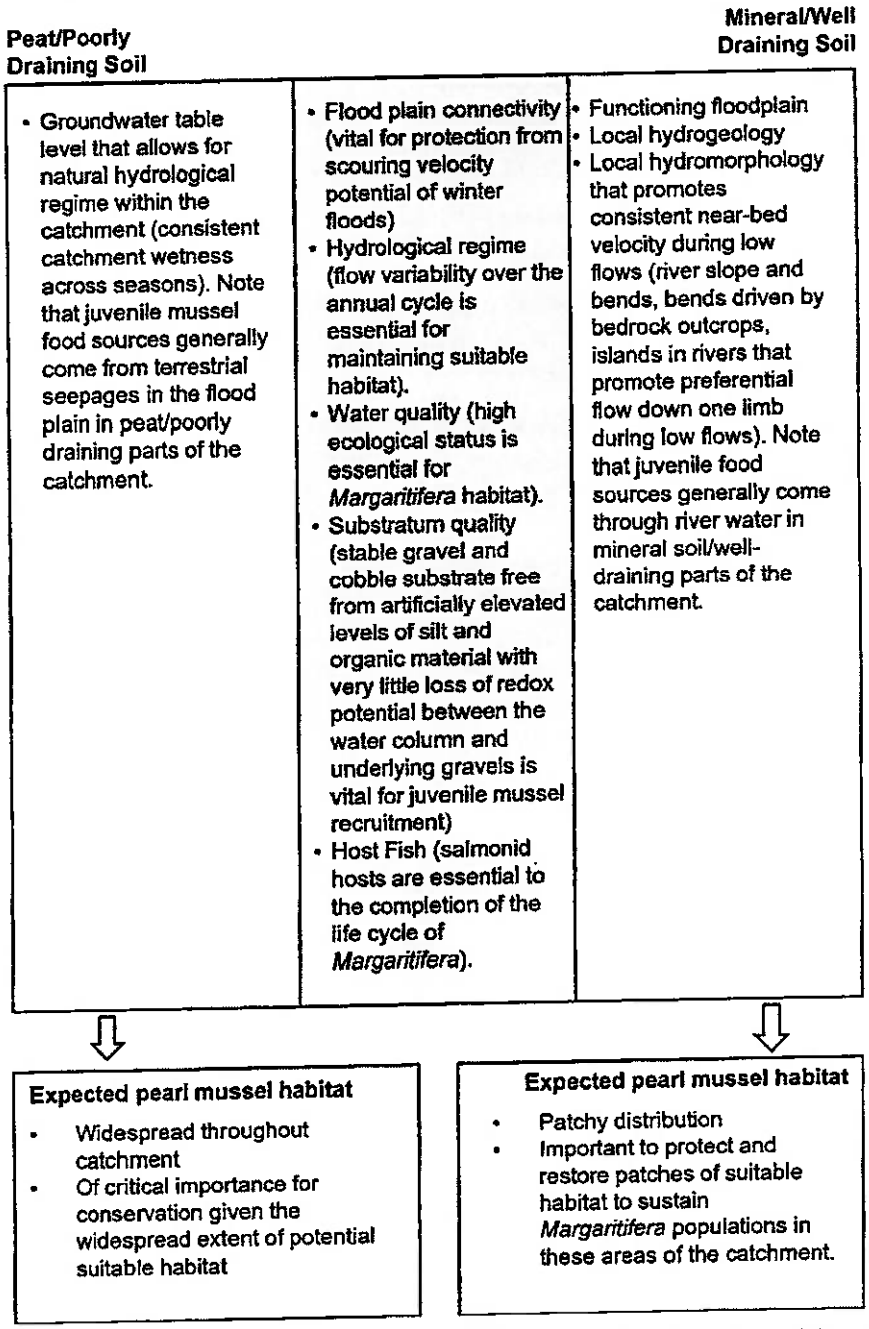

Figure 4.1. Drivers of *Margaritifera* habitat in mineral/well-draining soil and peat/poorly draining soil and description of expected pearl mussel habitat. Drivers common to both drainage scenarios are shown in the centre, whereas drivers that have more weight in a given drainage scenario are shown in left or right boxes as appropriate.

4.2 Using the conservation objectives to inform the potential risks of a project and the standards to be achieved by mitigation measures

The conservation objectives for *Margaritifera* in the Blackwater River (Cork/ Waterford) SAC are outlined in Table 3-1. The SSCOs provide the attributes and targets that define whether *Margaritifera* in the SAC is in favourable conservation condition. As the SSCOs define what favourable conservation condition is, they should form the basis for assessment for projects or plans that could impact *Margaritifera* within this SAC. The core risks that need to be considered, based on the SSCOs, can be summarised as follows:

- Potential impacts on *Margaritifera* distribution,
- Potential impacts on the restoration of populations,
- Potential impacts on the restoration of habitat extent,
- Potential impacts on the restoration of habitat quality in terms of substrate and water quality,
- Potential impacts on the restoration of hydrological regimes,
- Potential impacts on juvenile salmonid hosts.

The targets within the SSCOs can also be used as a standard to be achieved by mitigation. Mitigation measures should ensure that:

- Distribution of *Margaritifera* is not affected,
- The project will not prevent restoration of *Margaritifera* population size,
- The project will not prevent restoration of the following target for the structure of the *Margaritifera* populations: restore to least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length,
- The project will not cause unnatural population decline (no more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution),
- The project will not prevent the restoration of *Margaritifera* in more than 35km and any additional stretches necessary for salmonid spawning as indicated in map 8 of the COs (NPWS, 2012),
- The project will not prevent the restoration of water quality to a macroinvertebrate EQR greater than 0.90 and phytobenthos EQR greater than 0.93,
- The project will not prevent the restoration of substratum quality in terms of filamentous algae and macrophytes (<5% cover),
- The project will not prevent the restoration of substratum quality in terms of the presence of stable cobble and gravel substrate with very little fine material; with no artificially elevated levels of fine sediment,
- The project will not prevent the restoration of redox potential to no more than 20% decline from water column to 5cm depth in substrate,
- The project will not prevent the restoration of hydrological regimes,
- The project will not affect the maintenance of sufficient juvenile salmonids to host glochidial larvae.

Mitigation should be considered in a hierarchy consisting of avoidance, reduction or minimisation rehabilitation/restoration, and compensation. In relation to *Margaritifera*, avoidance is favoured. It may be achieved either through siting development in locations remote from any designated or extant *Margaritifera* populations with no discernible pathway for impact, or through the elimination of the pressure at source, e.g., containment of pollutants at source.

Figure 4.2 below shows a flow diagram which outlines an approach to assessing the implications of a project on *Margaritifera* within the Blackwater River (Cork/Waterford) SAC (002170) in view of SSCOs.

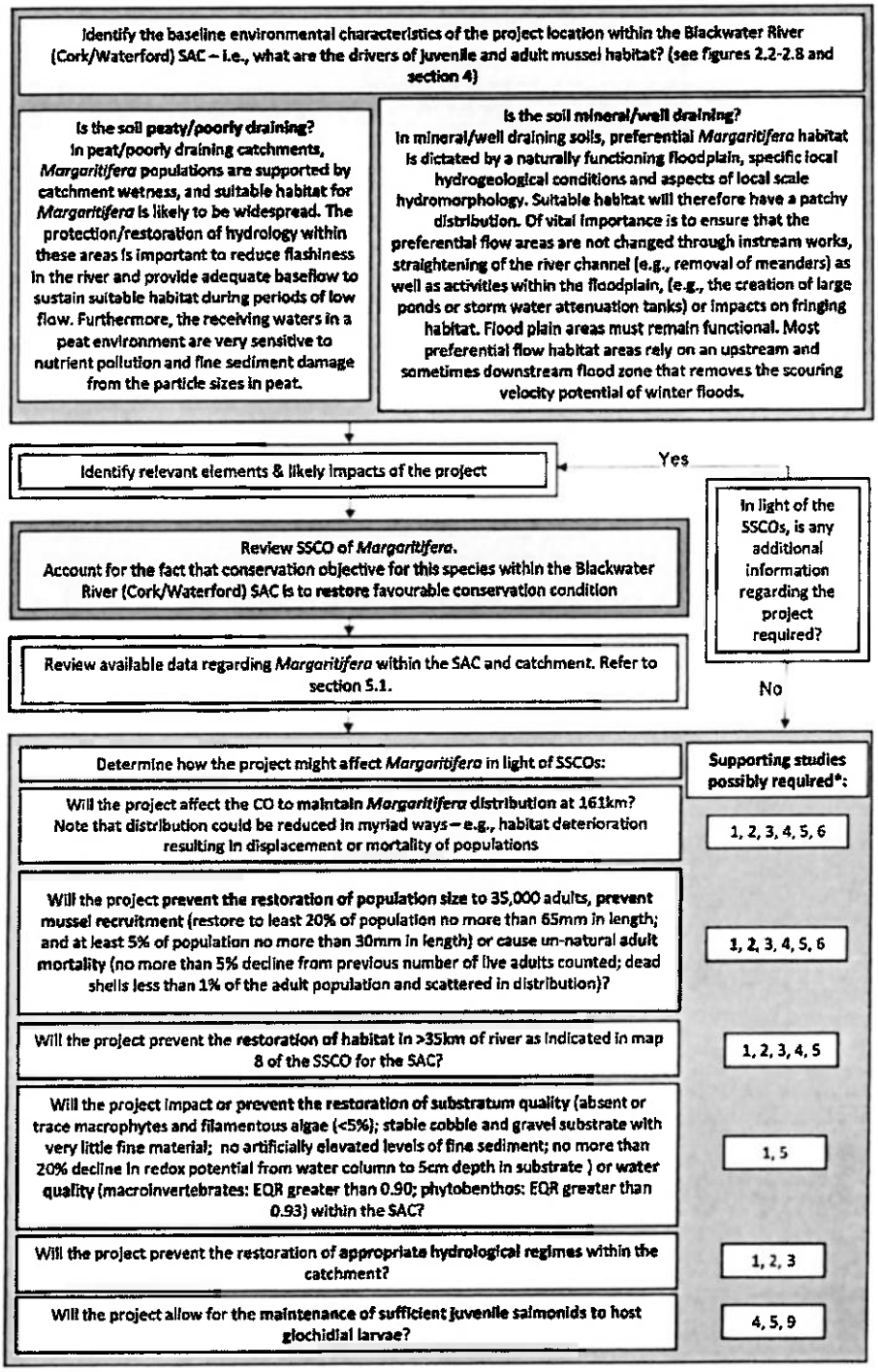

Figure 4.2. Flow diagram showing the approach to assessing the implications of a project on *Margaritifera* within the Blackwater River (Cork/Waterford) SAC (002170) in view of the Site's conservation objectives. The diagram highlights the importance of considering the environmental context of the project from the outset. The nature, scale and context of the project will determine the studies required to support the assessment.

*** Refer to Table 5-2 for the studies that correspond with the numbers indicated. Where supporting studies are not included as part of the assessment, the precautionary principle must be applied. Note, however, that the assessment cannot have lacunae.**

Table 4-1: Checklist to be completed to assist authors and competent authorities on assessing the impact of projects on *Margaritifera* within the Blackwater River (Cork/Waterford) SAC (002170).

Question	Supporting studies undertaken	Justification if no studies undertaken	Determination		
Will the project:			Project does not affect this CO without mitigation	Project does not affect this CO with mitigation	Not possible to mitigate (negative effect)
Affect the CO to **maintain *Margaritifera* distribution at 161km**?					
Prevent the restoration of population size to 35,000 adults?					
Prevent mussel recruitment (restore to least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length)?					
Cause un-natural **adult mortality** (no more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution)?					
Prevent the **restoration of habitat in >35km** of river as indicated in map 8 of the SSCO for the SAC?					
Impact or **prevent the restoration of substratum quality** (absent or trace macrophytes and filamentous algae (<5%) within the SAC?					
Impact or **prevent the restoration** of stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment within the SAC?					
Impact or **prevent the restoration** no more than 20% decline in redox potential from water column to 5cm depth in substrate) within the SAC?					
Impact or **prevent the restoration water quality** (macroinvertebrates: EQR greater than 0.90; phytobenthos: EQR greater than 0.93) within the SAC?					
Impact or prevent the restoration of **appropriate hydrological regimes** within the catchment?					
Allow for the **maintenance of sufficient juvenile salmonids to host glochidial larvae**?					

5 ASSESSING THE POTENTIAL IMPACTS OF PLANS OR PROJECTS ON *MARGARITIFERA* IN THE BLACKWATER RIVER (CORK/WATERFORD) SAC (002170)

5.1 Where can information on the *Margaritifera* population be found?

Details of where information on the *Margaritifera* can be found is provided in Section 3.2 of the main guidance document.

For the relevant population, a data request should be made to NPWS to access any survey data that can assist in understanding the area of influence, bearing in mind that fine sediment can travel and cause damage at least 25 km downstream, and a lot further over time as sediment settles and remobilises through the length of the river.

There have been a number of baseline surveys undertaken in the Munster Blackwater and Owentaraglin, but given the very long length of the potential mussel habitat these have covered only a very small area of the river. Much of the survey coverage comes from planning application assessment investigations.

The Allow population is better known, with a good baseline of 23km of river surveyed by the Duhallow LIFE project between 2012 and 2016 (IRD Duhallow, 2016). More recent updates come from monitoring studies to assess condition assessment of the population.

The Licky population has also had a detailed baseline study (Ross, 2003, 2005). More recent updates come from monitoring studies to assess condition assessment of the population.

Table 3.1 of the main guidance document lists the main sources of information available for all *Margaritifera* catchments. In relation to the Blackwater River (Cork/Waterford) SAC (002170) this will include the population data from survey returns required as part of the Wildlife Licence conditions, available through a sensitive data request, habitat and distribution extents from the SSCO, information from the sub basin management plan and boundary data on the SAC and sensitive area mapping.

5.2 What gaps in information need to be filled?

The possible gaps in information that need to be considered in the assessment of a plan or project are listed in Section 3.3 of the main guidance document. These gaps in information will need to be addressed for any assessments undertaken for *Margaritifera* within the Blackwater River (Cork/Waterford) SAC (002170).

Information on the population and habitat of *Margaritifera* in the Munster Blackwater, Allow and Licky catchments are limited (in particular for the Munster Blackwater due to the constrained nature of the survey effort in more recent times with surveys being restricted to presence or absence and total count surveys). Furthermore, caution is needed where surveys in all three catchments may be old and on this basis it is likely that further *Margaritifera* survey will be required to undertake a robust assessment of a proposed plan or project. Alternatively, the precautionary principal can be applied assuming that *Margaritifera* is present within the zone of influence of the plan or project and the assessment should be undertaken on that basis.

5.3 What information is needed about the plan or project in order to make an assessment?

The information required from a plan or project in more general terms is highlighted in Section 3.4 of the main guidance document.

The series of questions included in Table 5-1(Table 3.1 of the main guidance) are intended to provide focus for key issues relating to a *Margaritifera* related assessment specific to a particular plan or project. The questions will help to ensure that the assessment is complete and without gaps, considers risks relevant to *Margaritifera*, and may alert both regulators and project and plan developers to possible gaps and deficiencies.

Note that the list of questions is not exhaustive there will also be the requirement to provide more explicit and focused questions relating to particular sectoral activities that could also assist in undertaking an assessment of the potential impact on *Margaritifera*.

The series of questions in Table 5-1 are taken from the CEN European Standard - Water quality - Guidance standard on monitoring freshwater pearl mussel (*Margaritifera margaritifera*) populations and their environment (NSAI, 2017) and should be asked where short term activities or long terms plans or projects are being assessed for potential damaging effects on a *Margaritifera* population. These questions apply to activities in the catchment, where they could affect the river, and not just within the SAC boundary.

In the Blackwater River (Cork/Waterford) SAC (002170) it is important to understand the different physical characteristics of the catchment and how these can influence the potential impacts from a plan or project. As outlined in Section 4 the catchment characteristics have a strong influence on the long-term objectives of the *Margaritifera* populations depending on whether the physical setting is in the peaty, poorly drained areas of the catchment, i.e. to the north west or whether it is in the mineral, well drained soils to the south and east. Whilst the checklist of key questions with regard to the plan or project highlighted in Table 5-1 are applicable across the catchment it is important to distinguish the potential impact of a project in the two distinct physical characteristic areas of the Blackwater River (Cork/Waterford) SAC (002170).

Table 5-1. Checklist of questions that should be addressed to ensure that plans or projects do not damage *Margaritifera* populations.

Aspect	Question
Mussel Population	Will the plan or project result in humans, animals or equipment entering the river?
	Has the plan or project the potential to affect the annual reproductive cycle of the mussels?
	Will the plan or project increase the risk of pearl fishing, or direct disturbance to mussel beds?
Fish hosts	Has the plan or project the potential to affect the upstream or downstream migration of salmonids, including the timing of their movements?
	Has the plan or project the potential to affect the distribution or numbers of salmonid fish in the catchment?
	Has the plan or project the potential to affect the quality and distribution of salmonid spawning habitat?
	Has the plan or project the potential to affect the species composition of fish in the river?
Non-native species	Has the plan or project the potential to introduce or encourage the spread of non-native species to the river or catchment?
Water Quality	Will there be a new outfall or changes to an established outfall entering the river?
	Will changes to land management have the potential to increase nutrient loading to the river?
	Will the plan or project result in the concentration of nutrients that are currently more dispersed?
	Will any aspect of the plan or project potentially affect the temperature regime of the river?
	Will the plan or project change the pH of the water?
	Will any fertilizers be needed to establish or continue the project?
	Will the plan or project result in more intensive use of the catchment?
	Will the plan or project result in greater wastewater production in the catchment (increased human or animal loading)?
	Will any pesticides be needed to establish or continue the project?
	Will any potentially toxic substances be used in or generated by the project that would be damaging if they were to enter the river?
	Has the plan or project the potential to change the water quality of the river in any other way
Flow	Are there planned abstractions, or changes to abstraction levels or compensation flows?
	Will any planned changes in land management indirectly result in changes to the flow regime of the river?
	Is there any modification to drainage, or dewatering associated with the plan or project?
	Will any modification have the potential to change the stability conditions of the river bed?

Aspect	Question
	Has the plan or project the potential to affect the flow regime in the river in any other way?
Substrate Quality	Has the plan or project the potential to increase fine sediment loading to the river or within the river?
	Could works affect the supply of coarse sediment to the river?
	Will the plan or project potentially lead to erosion or bare soil in the catchment or directly adjacent to the river?
	Is there any new drainage or drainage maintenance associated with the plan or project?
	Are any instream works planned (e.g. gravel removal)?
	Are any structures planned close to the river, within or across the river (e.g. installing flow deflectors)?
	Are there any bank reprofiling or bank engineering plans?
Riparian landuse	Has the plan or project the potential to affect the nature of the riparian habitat in the river?
	Has the plan or project the potential to affect the nature of the floodplain?
Vibration and drilling / blasting /noise	Has the plan or project the potential to affect the mussels or their hosts through damage arising from vibration and drilling / blasting /noise?

5.4 Technical information on the operational stage of the project needed to make an assessment specific to the Blackwater River (Cork/Waterford) SAC (002170)

As outlined in Section 2.5 there are a wide range of pressures and threats acting on the Blackwater River (Cork/Waterford) SAC (002170) which are resulting in the unfavourable conservation status. The pressures and threats that were classified as severe are summarised below:

- Diffuse pollution to surface or ground waters from agricultural and forestry activities;
- Drainage for use as agricultural land;
- Modification of hydrological conditions, or physical alteration of water bodies and drainage for forestry (including dams);
- Residential and commercial activities and structures generating pollution to surface or ground waters;
- Conversion into agricultural land (excluding drainage and burning);
- Livestock farming generating pollution;
- Conversion to forest from other land uses, or afforestation (excluding drainage);
- Peat extraction;
- Active abstraction of water for built-up areas.

The conservation objective of "restoring" favourable conservation condition in the Blackwater River (Cork Waterford) SAC is important, as implicit in this conservation objective is the need for all plans and project potentially affecting *Margaritifera* to demonstrate that any activities associated with them will either contribute towards the objective of restoration or at the very least will not prevent restoration being achieved. To this end, any project within the SAC must demonstrate that the design of the project and the operating regime can be implemented in a manner that is supportive of the restoration of the conservation status of *Margaritifera* or at the very least must not introduce impediments to the achievement of this objective.

It is imperative that the plan developers or project proponents support the assessment of the plan or project with an evidence base that demonstrates such a design and operating regime will not result in significant impacts given that it is well established in case law that the AA (and the NIS that informs it) must contain

complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposed plan or project on a European site(s) (C-304/05)[4].

Section 3.5 of the main guidance document outlines the technical information required to assess the operational impacts from a plan or project in SAC catchments where *Margaritifera* is a qualifying interest. The information is not repeated in this document but some specifics in relation to the Blackwater River (Cork/Waterford) SAC (002170) are discussed below.

5.4.1 Poorly drained areas of the catchment

Understanding how the hydrological regime within a catchment can be impacted by a plan or project activities forms a fundamental element in assessing the potential for damage in a *Margaritifera* catchment. The physical conditions in the north and west of the Munster Blackwater catchment, the Allow catchment and the upper reaches of the Licky catchment are typical of many high-status objective (HSO) sites in Ireland, with more than 80% of these catchments having poorly draining characteristics (Waters of Life, 2023).

When assessing plan or project activities in these poorly draining areas, the focus should concentrate on whether the activities will contribute to the speeding up of hydrological processes within the catchment, giving rise to greater extremes in physical and water quality conditions in receiving watercourses. This includes greater erosive power and an increase in the deposition of finer grained material during low flows. Water quality degradation can occur in these circumstances, as shallower pathways dominate contaminant delivery, particularly for particulate contaminants (sediments and adsorbed nutrients/pesticides). Furthermore, artificial drainage within poorly draining areas reduces the delivery of near-surface, nutrient poor water during low flows, resulting in reduced velocities required to sustain juvenile *Margaritifera* habitat and cleanse the substrate whilst also increasing levels of mineralisation in streams. Drainage density is often high in poorly draining catchments, and the installation of artificial drainage is common. Figure 5.1, taken from the Waters of Life framework for the protection and restoration of high-status objective (HSO) sites (Waters of Life, 2023) is a conceptual model of the types of pressures that can result in an impact on the hydrology of the catchment and affect catchment wetness and ultimately *Margaritifera* and its habitat.

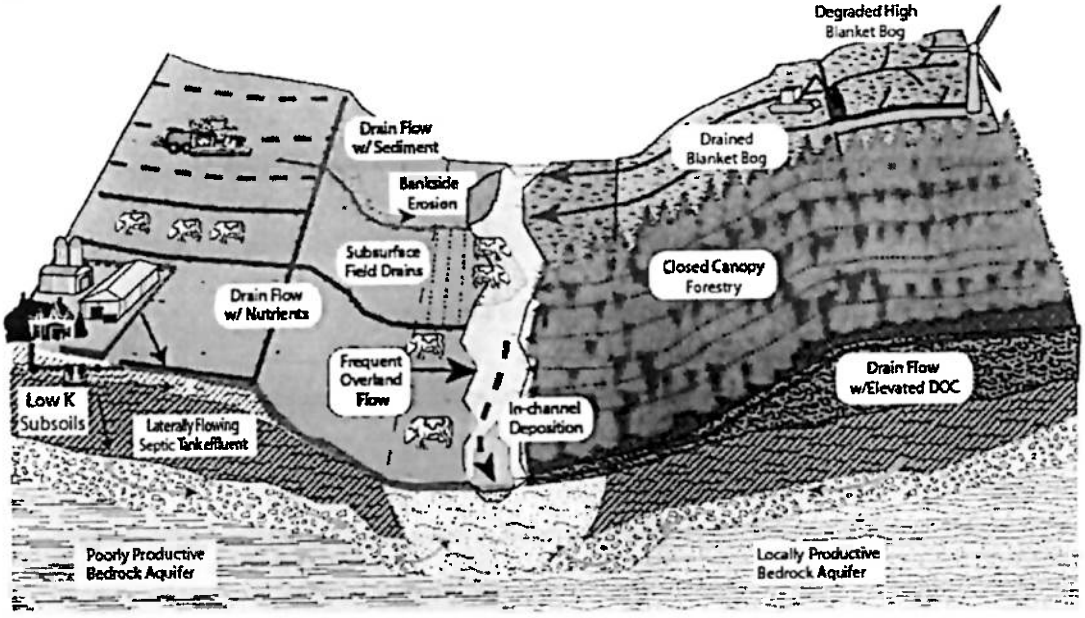

Figure 5.1: Schematic conceptual model of pressures giving rise to the degradation of high status objective (HSO) rivers and streams.

[4]https://curia.europa.eu/juris/document/document.jsf?text=&docid=62977&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=491072

Where impermeable soils, highly erodible soils such as peat, or a high water table are present, as is the case in the poorly draining areas of the catchment, developments will pose a much higher risk of nutrient and fine sediment losses to water, and of changes to hydrology. In such sites mitigation to prevent damage is extremely difficult and may well be insurmountable and prevent the project proceeding. Onsite sewage treatment for example may not be possible in certain circumstances. Any proposed new development should clearly detail the measures being proposed to prevent such impacts. Existing development on such soils must be carefully managed in a manner that mitigates significant risk. Areas where peat soils are common pose particular problems for proposed developments.

The potential for hydrological change and erosion in the area between the proposed development site and the river, and risks to the *Margaritifera* population must be assessed. Where peat or other easily eroded soils (which are common in this part of the catchment) are present along drainage pathways, the risk is exacerbated. Where removal of peat on sites with such drainage features is required, it must be carefully planned, and managed in a manner that mitigates all significant risk. If risks cannot be removed the proposed development should not proceed.

5.4.2 Naturally well drained areas of the catchment

Margaritifera have a more naturally restricted distribution in the naturally well-drained areas of the Munster Blackwater, Allow and Licky catchments. As outlined in section 4.1 and the flow chart in **Figure 4.2**, in these areas preferential *Margaritifera* habitat is maintained by a naturally functioning floodplain, specific local hydrogeological conditions (see section 2.2.2) and aspects of local scale hydromorphology. Accordingly, *Margaritifera* habitat targets in the freely draining areas of the SAC, such as the main Blackwater channel (Figure 2.11) show a more patchy distribution of suitable habitat. When considering the information required to assess the impacts of a plan or project in the well-drained areas of the catchment, it is important to consider those activities that have the potential to impact on the preferential flow areas of *Margaritifera*, such as instream works and changes to the hydromorphology of the channel (e.g., removal of meanders). In addition, it is important to obtain information on the project activities within the floodplain that could impact on the ability of the floodplain to provide a regulatory function in terms of buffering flood flows ensuring that lateral floodplain connectivity is maintained and floodplain storage is not reduced. This is to ensure that during flooding, the buffering of the flows through floodplain storage means the erosive capacity in the channel is not increased to a level that results in scour and erosion on *Margaritifera* habitat. The function of the floodplain in these areas during low flows is also very important where the waterlogged soils and subsoils can provide base flow to the mussel habitat but also denitrification to reduce possible nitrate pollution.

These questions need to be asked with respect to the conservation objectives of a population, in the case of the Blackwater River (Cork/Waterford) SAC (002170) this will be the "restore" function for each of the conservation objectives. It requires assessment of projects that may previously been regarded as continuation of the status quo, such as a new agricultural scheme following on from an older one, or for felling and replanting forestry, or demolishing and rebuilding structures including roads. The consideration of alternatives that allow for restoration of habitat in the Blackwater River (Cork/Waterford) SAC (002170) must be the basis for assessment.

5.5 Technical information on construction design and implementation specific to the Blackwater River (Cork/Waterford) SAC (002170)

Section 3.6 of the main guidance document outlines the technical information required to assess the construction impacts of a plan or project in SAC catchments where *Margaritifera* is a qualifying interest and provides some detail in relation to the site characteristics that must be considered during the construction of a project. The information is not repeated in this document but some specifics in relation to the Blackwater River (Cork/Waterford) SAC (002170) are discussed below. At all times water quantity and quality arriving at mussel habitat must not be negatively impacted. Ensuring that no fine sediment, nutrient and other harmful pollutants reach the aquatic zone must be demonstrated.

5.5.1 Poorly drained areas of the catchment

Maintaining natural flow variability in *Margaritifera* catchments is an essential requirement for a fully functioning population, including enough high flows to cleanse river-bed substrates. The most appropriate

way of ensuring adequate flow in *Margaritifera* populations is to maintain a natural, abstraction-free regime in the sub-catchment influencing the population, and to manage the surrounding catchment in a manner that does not affect the natural flow regime. In the poorly drained areas of the Munster Blackwater, Allow and Licky catchments this means that restoration of hydrology within these areas is important to reduce flashiness in the river and provide adequate baseflow to sustain suitable habitat during periods of low flow. Furthermore, the receiving waters in a peat environment are very sensitive to nutrient pollution and fine sediment damage from the particle sizes in peat. Therefore, restoration of catchment hydrology in these areas is key and the project must, at the very least, ensure that the construction does not prevent or delay the recovery of the hydrological regime to that which is supportive of a fully functioning population. Therefore, it is essential to assess the impacts of construction drainage (including the siting of construction settlement ponds or similar in unsuitable areas that impact on natural or semi natural habitats) or other unsuitable land use change during construction e.g. hardstanding areas, to ensure that the construction of the project does not significantly impact on the natural flow regime or result in nutrient and fine sediment pollution.

5.5.2 Naturally well drained areas of the catchment

Construction by its nature involves the disturbance of soils and in many cases removal of rock outcrop or underlying strata in order to provide a site suitable for the proposed development. Such works which may include cut and fill operations, contour reprofiling, and excavations can also result in the removal or degradation of protective fringing habitat such as semi natural and natural riparian habitats. This increases the risk of sediment and nutrient movement to watercourses and can impact on the structure and functioning of river systems particularly the flow regime.

Local hydromorphological processes are important in the well drained areas of the catchment where local geomorphological conditions dictate the location of suitable *Margaritifera* habitat, e.g. river slope and bends, bends driven by bedrock outcrops, islands in rivers that promote preferential flow down one limb during low flows consistent near-bed velocity during low flows.

In the naturally well drained areas of the catchments, the fringing semi-natural and natural habitats both within and outside of the floodplain are critical to the regulation of flow regime and provide a buffering to sediment and nutrient loading to the river. Note that juvenile food sources generally come through the fringing habitat in mineral soil/well-draining parts of the catchment. Open wetlands, such as wet heath and blanket bog, are particularly critical to the hydrological regime of mussel rivers, as are rush-dominated wet grassland habitats.

It is therefore critical that the construction of a project does not impact on the supporting fringing habitat, and result in degradation of the sensitive habitat to ensure that condition of this habitat is not adversely affected so that the fringe habitat is sufficient to allow the species to maintain itself on a long-term basis. A project that steps back from the river and creates a buffer zone that can improve the restoration of fringing habitats can be considered to support the restoration objective of the SAC, even if that land is outside the boundary of the SAC.

5.6 Proper application of the precautionary principle

The precautionary principle should be rooted in any assessment of the potential impacts of a plan or project on *Margaritifera* - i.e., the absence of evidence on the effects of an action on *Margaritifera* cannot be used as justification for support of this action. Accordingly, any conclusions drawn in relation to the impact of plans or projects on *Margaritifera* must be supported by a robust evidence base. If the potential for adverse effects cannot be excluded, they must be assumed. In addition, the precautionary principle should also be applied during the establishment of the evidence base. For example, for developments where *Margaritifera* are an ecological receptor and dedicated surveys have not been undertaken, the precautionary principle should be applied, and it must be assumed that *Margaritifera* are present within affected waterbodies and the assessment must be made on this basis.

In relation to Appropriate Assessment (discussed further in the following sections), the need to apply the precautionary principle has been confirmed by European Court of Justice case law (e.g., C-441/17 European Commission v Republic of Poland and C-254/19 Friends of the Irish Environment Ltd v An Bord Pleanála).

5.7 The Appropriate Assessment screening process

The Habitats Directive (92/43/EEC) provides legal protection for habitats and species of European importance. As per Article 6(3) of the Habitats Directive, plans and projects must undergo an assessment of their implications for any European site before they can be authorised by the competent authority. To this end, a screening process must be carried out for all plans and applications for planning permission, in order to determine if an Appropriate Assessment (AA) is required. This is known as "screening for Appropriate Assessment" or "stage 1" AA. The purpose of this 'assessment is to determine whether a plan or project is directly connected with or necessary for the management of the European Site(s), or whether a plan or project, alone or in combination with other plans and projects, is likely to have significant effects on the European Site(s) in view of its conservation objectives.

Appropriate Assessment screening can be carried out in four steps (EC, 2022):

1. Determining whether the plan or project is directly connected with or necessary to the management of a European Site;
2. Identifying the relevant elements of the plan or project and their likely impacts;
3. Identifying which (if any) European Sites may be affected, considering the potential effects of the plan or project alone or in combination with other plans or projects;
4. Assessing whether likely significant effects on the European Site can be ruled out, in view of the Site's conservation objectives.

Please refer to the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments" for further detail on the AA screening process.

Any plan, or application for planning permission within the Munster Blackwater catchment, will need to be subject to screening for AA. A Screening for AA report can be included by an applicant as part of a planning application, however, screening for AA must be carried out by the planning authority or An Bord Pleanála as the competent authority, irrespective of whether the applicant submits a screening report. The competent authority can have regard to any report included with the application, however the competent authority is not bound to reach the same conclusion (OPR, 2021). *Margaritifera* populations and their host fish outside the boundaries of the Blackwater River (Cork/Waterford) SAC are protected under Article 6(2) of the Habitats Directive and the implications for them must also be examined under Article 6(3) if those implications are liable to affect the conservation objectives of the SAC.

5.8 How to determine whether a plan or project is 'likely to have a significant effect thereon, either individually or in combination with other plans or projects'

Extensive information in relation to determining whether a plan or project is likely to have a significant effect on *Margaritifera* within SAC catchments, either individually or in combination with other plans or projects, is provided in section 3.8 of the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments." This information is readily transferable to assessments undertaken within the Blackwater River (Cork/Waterford) SAC (002170)and is therefore not repeated here.

It is important to note that in-combination effects must also be assessed for permitted developments that may pre-date the Habitat's Directive and have never undergone Appropriate Assessment. If any changes, upgrades or ancillary projects in any way relating to historical projects are planned in a *Margaritifera* catchment, it is important to note that the full operation, system, plan or project in its entirety needs to be taken into the assessment. This brings into the assessment system projects that may never have been assessed before, even if they are not proposed to be changed as part of the new plans.

5.9 Content of Appropriate Assessment or NIS in view of the site's conservation objectives'

5.9.1 Form of the assessment

In Ireland, an AA takes the form of a Natura Impact Statement (NIS), which must contain an assessment of all the aspects of the plan or project which can, either individually or in combination with other plans or projects, affect the conservation objectives of a European Site. The assessment must be undertaken in the light of the best scientific knowledge in the field, and based on objective scientific evidence and methods. Please refer to the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments" for further detail on the form of the AA.

5.9.2 Content of the assessment

The AA (and the NIS informing the competent authority undertaking the AA) must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposed plan or project (C-304/05)[5]. The AA must be undertaken in light of the conservation objectives of the Site, and therefore it is essential that the Site-Specific Conservations Objectives (SSCOs) for the Site are taken into account as part of the AA. The site-specific conservation objectives for *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002170) are outlined in section 3.4 above. The conservation objective of "restoring" favourable conservation condition is important, as implicit in this conservation objective is the need for all plans and project potentially affecting *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002170) to demonstrate that any activities associated with them will either contribute towards the objective of restoration or at the very least will not prevent restoration being achieved.

Given its highly sensitive nature, undertaking AA for *Margaritifera* populations is challenging and will often require detailed scientific studies. The type of supporting studies required to support the AA will vary on a case-by-case basis depending on the nature and location of the project or plan and the potential impacts associated with it (although it is important to bear in mind that in some instances, certain impacts may not become apparent until detailed survey work has been undertaken – e.g., potential hydrological impacts). The types of possible supporting studies required is outlined in Table 5-2.

Sections 5.1 to 5.5 of this document highlight the essential information required to undertake an AA for *Margaritifera* populations within the Blackwater River (Cork/Waterford) SAC (002170). Consideration should also be given to Table 8 of the CEN standard for *Margaritifera* (NSAI, 2017).

The layout of assessment reports that will be transferred for consideration by a competent authority for the purpose of AA should provide a clear link between all studies and justifications with every one of the targets listed under the Conservation Objectives for the relevant population(s).

The potential impacts should be recorded and ideally quantified using parameters that make it possible to assess the scale and severity of the impact on the SSCO of the *Margaritifera* populations. As noted previously in this section, not only should the assessment consider impacts on the current status of *Margaritifera* in the SAC, but also changes or continuation of the status quo that could prevent the restoration of the population within the SAC.

Once the potential impacts of a plan or project have been identified, the AA must identify mitigation measures to avoid or reduce potential adverse effects. As per the mitigation hierarchy, in the first instance, avoidance measures should be implemented where possible, followed by measures aimed at reducing the severity of impacts or eliminating them entirely. An assessment of residual impacts should also be included. If the assessment is negative, i.e., adverse effects on the integrity of a site cannot be excluded, even with the application of mitigation measures, then the project or plan may not proceed without continuing to stage 3 of the AA process: Alternative Solutions. The AA report should be sufficiently detailed to demonstrate how the final conclusion was reached, and on what scientific grounds.

[5] https://curia.europa.eu/juris/document/document.jsf?text=&docid=62977&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=491072

Table 5-2. Studies which may be required to support AA of a plan or project in a *Margaritifera* SAC.

Number	Study	Examples of why this study might it be required	How can it be undertaken?
1.	Fluvial Geomorphological Study	To gain an understanding of baseline hydrological regime of a river, and how a plan or project might affect it. To identify hydrological pathways to the SAC during the lifetime of a plan or project. In instances where riverbank or instream works are proposed, it may be necessary to undertake dedicated fluvial geomorphology investigations to establish the baseline and predict how a plan or project will affect sediment transport and other geomorphic processes within the river. To gain an understanding of the baseline physical habitat condition within the river (e.g., identification of various river habitats, instream structures, evidence of bank erosion, evidence of nutrient enrichment, evidence of siltation) and to understand how the plan or project might affect it.	Hydrological modelling Sediment transport modelling Fluvial audit River Hydromorphological Assessment Technique (RHAT)
2.	Hydrogeological Study	To gain an understanding of the hydrogeological context of a plan or project and how the plan or project might affect the baseline hydrogeology. To identify hydrogeological pathways to the SAC during the lifetime of a plan or project. Modelling may be used to assess the current hydrogeological impacts in a catchment, and remote sensing can be used to assist a model (Kuemmerlan et al., 2021).	Hydrogeological survey & monitoring
3.	Hydrological modification study	Understanding hydrological structure and function of a study site with respect to its sub-catchment requires a detailed understanding of the hydrological processes within each sub-catchment. The observed degree of hydrological modification is an indicator of hydrological structure and function. Areas where hydrology has been largely unmodified and will not be modified can be classified as low risk. Areas where the hydrology has been modified through drainage and/or land use change can be classified as medium risk or high risk depending on the level of modification.	Comparison with old maps, ecological studies of habitat condition
4.	Habitat Survey	Habitat surveys are important to understand the extent and condition of riparian buffer zones, identify hydrological pathways to the river habitat in which *Margaritifera* occur (e.g., drainage ditches), establish baseline land use, identify wetland habitat which may carry out an important role in flow regulation and provide an essential food source for juvenile mussels.	Walkover habitat survey
5.	Water Quality Monitoring	Water quality monitoring may be required to understand the baseline water quality in the receiving *Margaritifera* catchment and therefore how any changes arising from the project or plan might affect *Margaritifera*.	Turbidity monitoring, macroinvertebrate assessment, water chemistry monitoring, redox potential studies

Number	Study	Examples of why this study might it be required	How can it be undertaken?
6.	Stage 1 & 2 *Margaritifera* survey	Establish presence/possible absence of *Margaritifera* in a river and if present, estimate the adult population size.	Stage 1 & 2 *Margaritifera* survey by licenced surveyor
7.	Stage 3 *Margaritifera* survey	Establishment of whether or not there is recruitment to the mussel population in a river. Stress testing of adult mussels. Survey methodology is potentially very destructive of mussels. This type of survey is unlikely to be required as part of an AA for a plan or project.	Stage 3 *Margaritifera* survey by licenced surveyor
8.	Stage 4 *Margaritifera* survey	Repeat monitoring of *Margaritifera* and their habitat (combining survey techniques used in Stages 2 and 3 with recording of water quality parameters and detailed river channel character data, at prescribed intervals in time and space). This type of survey is unlikely to be required as part of an AA for a plan or project.	Stage 4 *Margaritifera* survey by licenced surveyor
9.	Electrofishing Survey	Establishment of baseline salmonid population structure. This type of survey is unlikely to be often required as part of an assessment, and it may be possible to obtain fish population structure data from Inland Fisheries Ireland.	Electrofishing Surveys (e.g. depletion electrofishing).

Refer to the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments" for further detail on mitigation measures and alternative solutions.

5.10 Decision-making

Competent national authorities are those authorised to consent to a plan or project (e.g., local authorities or An Bord Pleanála). Under Article 6(3) of the Habitats Directive, the competent authorities can only consent to a plan or project once it is certain that the plan or project will not adversely affect the integrity of a European Site.

A competent authority is assisted in its AA by the relevant NIS and associated studies. An AA process at this stage that relies on third party reports should check very carefully that all the justifications for a positive assessment are complete and correct for all of the Conservation Objectives for the relevant SAC population(s).

When a local authority makes a planning decision, the decision can be appealed within 4 weeks of the date of the local authority's decision. An Bord Pleanála will then either grant permission as before, grant permission with amended conditions, or refuse permission.

Following the Bord's decision, there is an 8 week period in which judicial review proceedings can be commenced in the High Court, which will ultimately rule on the legality of the planning permission.

It is important for the safe and smooth running of the planning system that information for assessments provided by developers, and the assessments made by the planning authorities should be absolutely thorough and checked to be correct. It must be noted that if there was shown to be a flaw in the planning assessment made, even if discovered after the period for judicial review has expired, there is an obligation to protect the site from damage under Article 6.2 (see e.g. CJEU Case C-399/14 (Grune Liga Sachsen)).

5.11 Article 6.4

Article 6(4) of the EU Habitat's Directive allows for exceptions to the general rule of Article 6(3) – i.e., the Directive provides for limited circumstances where, in spite of a negative assessment of the implications for a European site and in the absence of alternative solutions, a plan or project must nevertheless proceed for imperative reasons of overriding public interest. This is referred to as "IROPI." Before planning permission

under Article 6(4) can be granted, a number of key conditions and requirements must first be met and documented, these are as follows (EC, 2019):

- the "alternative solution" put forward for approval is the least damaging for habitats, species and for the integrity of the European site(s), regardless of economic considerations, and no other feasible alternative exists that would not adversely affect the integrity of the site(s);
- there are imperative reasons of overriding public interest, including those of a social or economic nature;
- all compensatory measures necessary to ensure that the overall coherence of the Natura 2000 network is protected are taken.

Further detail on Article 6(4) of the Habitats Directive is available in section 5 of the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments".

6 MITIGATION MEASURES FOR *MARGARITIFERA* IN THE BLACKWATER RIVER (CORK/WATERFORD) SAC (002170)

6.1 Introduction

Activities that occur in catchments where *Margaritifera* is known to be present must be shown to be sustainable, i.e. that the activity will not have a significant negative impact on the species or its habitat, or on the restoration of the population. If the potential for impact exists then mitigation, as required by the Habitats Directive, is necessary. In relation to SAC catchments, it is essential to demonstrate that the activities will not cause a deterioration in the habitat or a disturbance to the species in the context of an appropriate assessment as required by Article 6.

Mitigation means the removal beyond reasonable scientific doubt of the risk of impact and the achievement, or potential to achieve, favourable conservation status.

The preferred sequence of mitigation measures is first to avoid impacts at source and then minimize pressures through measures that will reduce and abate possible impacts at source or on site. Measures to prevent impact can include siting activities in areas where there is no pathway to allow impact to occur, or eliminating the pressure at source, e.g. prevention of elevated suspended solids in *Margaritifera* habitat through strict control measures at source (silt fencing in terrestrial conditions). In this regard it is important to consider in-combination effects of all pressures. Where risk of impact cannot be adequately mitigated, alternatives must be considered, including locating the activity outside the *Margaritifera* SAC catchment or in areas where no potential for impact arises.

When considering proposed mitigation measures, the Habitats Directive assessment should assess their feasibility in terms of the resource requirements for their implementation, management, maintenance and monitoring. Only mitigation that is assured beyond reasonable scientific doubt to be effective in the particular circumstances in which it is to be deployed is acceptable. All proposed mitigation must be specified (including exact location and design, and all relevant environmental parameters) so that it can be assessed for effectiveness and other possible impacts. For example, excavation of sediment retention ponds or lagoons may create new risks of sediment release or changes to the flow regime. Mitigation should also consider contingencies for unforeseen or unscheduled events.

Mitigation must be based on a clear understanding of baseline environmental and the overall landscape conditions in the operational area, and in the vicinity of any downstream *Margaritifera* populations. Where the project includes preparatory site works or construction, the proposed mitigation must include detailed and robust management protocols and auditable records.

In all instances mitigation measures must be appropriate to the potential risk associated with the activity.

In the Blackwater River (Cork/Waterford) SAC, the highest level of diligence is needed at all stages from planning applications through to project completion and indeed to the end of operation and decommission. In order to gain permission for a project in the catchment a very detailed design, description of construction and operation, and means by which they can be undertaken safely will be needed, with evidence to demonstrate that the project operation will have no negative effects, and that construction mitigation measures are capable of removing any risk of harm during the construction phase.

The proof of the functionality of mitigation measures should be based on well-established evidence of their value. With all of these safeguards in place, permission can be given, generally with the condition that all mitigation measures are undertaken as defined within the planning application. The permissions may require the presence of an independent Ecological Clerk of Works. Thus theoretically, the project can be completed without harm.

6.2 Mitigation by avoidance

Mitigation or control measures will depend on appropriate implementation and local site conditions (including factors like soil type, slope, drainage, terrestrial habitat, landscape features and characteristics of the receiving environment). In all cases the statutory burden of proof lies with the project proponent, developer or operator of the development or activity to show conclusively beyond reasonable scientific doubt that the

control measure, or combination of measures will mitigate any significant impact on the *Margaritifera* based on the conservation objectives and supporting water quality standards.

Avoidance is the most common, and most preferable approach, whilst the abatement or rehabilitation of impacts at the receptor is undesirable. Mitigation should consider the alternative of locating activities outside *Margaritifera* catchments, or in remote locations where pathways to *Margaritifera* populations and habitat do not exist, and impact is therefore not possible.

6.3 Mitigation Measure Strategy

The mitigation measure strategy that should be employed in the Blackwater River (Cork/Waterford) SAC (002170) is outlined in Section 6.4 of the main guidance document.

At the forefront of considerations should be the ability to demonstrate, with evidence, that the project operation will have no negative effects on the *Margaritifera* populations. In this regard the operational impacts across the lifetime of the project must be considered in the first instance and only when it has been established that potential operational impacts can be mitigated to ensure that the plan or project will not prevent or delay the *Margaritifera* population in the Blackwater River (Cork/Waterford) SAC (002170) reaching favourable condition should the question around whether the plan or project be constructed or decommissioned safely arise. The flow chart in Section 6.4 of the main guidance document (reproduced in **Figure 6.1**) should be followed.

When considering the mitigation measures for *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002170) it is important to consider the conservation objectives that have been assigned for the species in the context of the restore function as the population is currently not achieving favourable condition.

Table 6-1 below summaries the 13 conservation objectives for the Blackwater River (Cork/Waterford) SAC (002170) population. An indication of the requirements for the restore function is outlined for each conservation objective. The onus is on the plan or project developer to demonstrate through their assessment, with suitable modelling where necessary, that the operation of the project will not adversely impact on impede the restoration of conservation status.

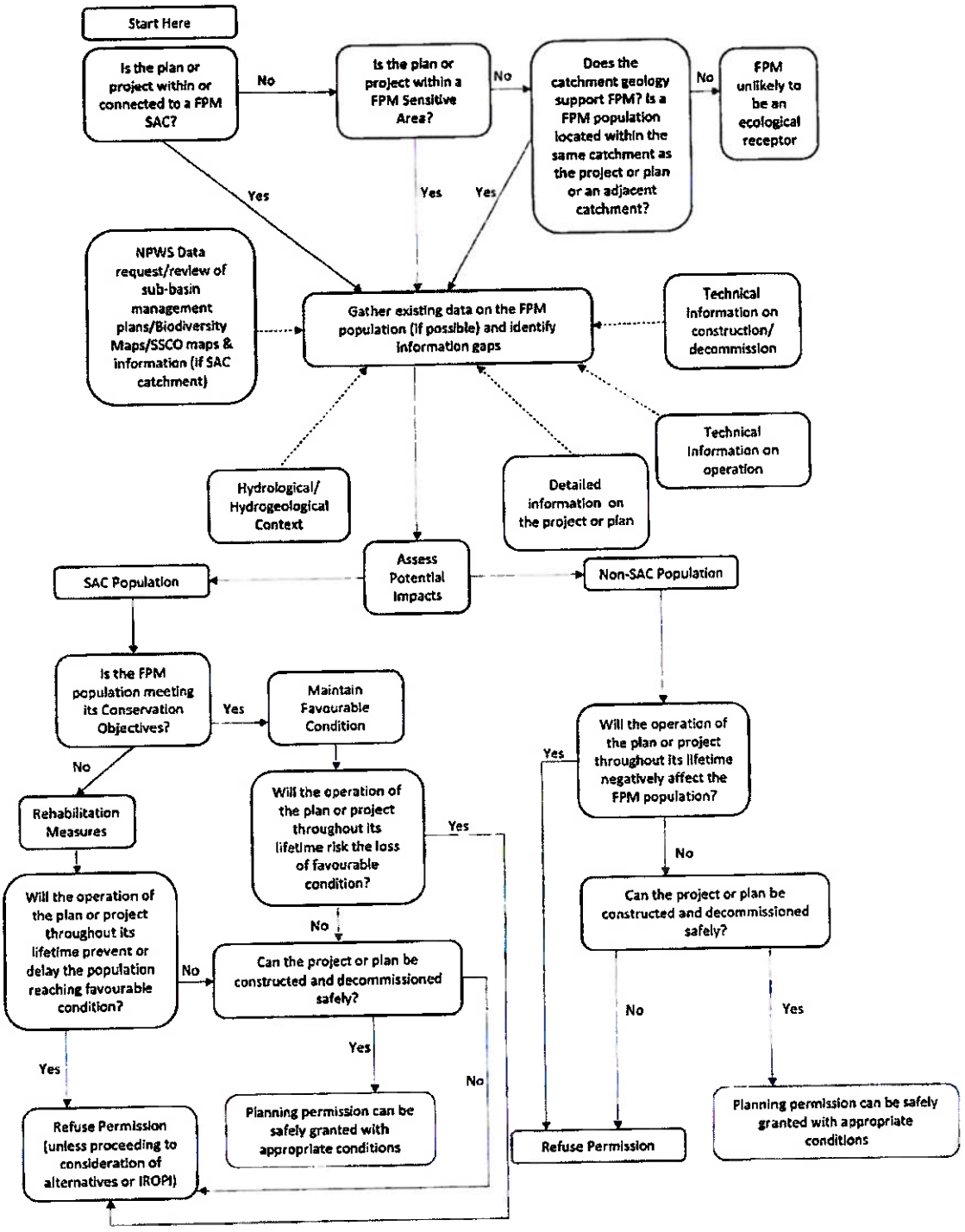

Figure 6.1 *Margaritifera* Impact Assessment Process

Table 6-1: Conservation objectives for the Blackwater River (Cork/Waterford) SAC *Margaritifera* Populations

Conservation Objective	Target	Mitigation – Restore (maintain for distribution) Function
Distribution	Maintain at 161km	The plan developers or project proponents must demonstrate the value of their plan or project in this conservation objective. The objective is to maintain the existing distribution at 161 km therefore avoidance of direct impact on the *Margaritifera* population is essential and the supporting habitat within this distribution must not be impacted by the plan or project to ensure the species sufficiently widespread to maintain itself on a long-term basis.
Population Size	Restore to 35,000 adult mussels	Plan or project should not prevent or delay the recovery of the population to favourable condition as a minimum. The mitigation for the plan or project must ensure that there is no risk of direct mortality and, as a minimum, does not impede the restoration of the habitat condition, including the substratum quality, flow regime, water quality and fringing habitats, to that which would support sustainable population losses, i.e. those that would be considered consistent with natural fluctuations. The proposers should demonstrate, where relevant, their contribution to further improvements in the supporting habitat to assist in the re-establishment of a sustainable population size that is sufficiently abundant to maintain itself on a long-term basis.
Population Structure: Recruitment	Restore to least 20% of population no more than 65mm in length; and at least 5% of population no more than 30mm in length	Young mussels are considered to be ≤ 65mm whilst juvenile mussels are ≤ 30 mm in length. Both cohorts are buried in the substratum and therefore rely on suitably clean stable substratum with the correct hydrological regime and good oxygen exchange with the water column. Impacts that can potentially affect the quality of the substratum, flow conditions and fringing habitat or could prevent the restoration of these The plan or project should not prevent or delay the recovery of juvenile recruitment as a minimum. The proposers should seek to demonstrate the value of their plan or project in this conservation objective and where relevant its contribution to further improvements in the supporting habitat to assist in the re-establishment of a juvenile recruitment to a level that is sufficient to maintain itself on a long-term basis.
Population Structure: adult mortality	No more than 5% decline from previous number of live adults counted; dead shells less than 1% of the adult population and scattered in distribution	Mitigation for the plan or project must ensure that there is no risk of direct mortality and that the habitat condition including the substratum quality, flow regime, water quality and fringing habitats is not compromised to an extent that there are unsustainable population losses above what would be considered to be natural fluctuations resulting in the loss of favourable condition. The plan or project should not prevent or delay the recovery of the population to favourable condition, as a minimum. The proposers should seek to demonstrate the value of their plan or project in this conservation objective and where relevant its contribution to further improvements in the supporting habitat to reduce adult mortality to natural levels so that the population has the ability to maintain itself on a long-term basis.

Conservation Objective	Target	Mitigation – Restore (maintain for distribution) Function
Suitable Habitat: Extent	Restore suitable habitat in more than 35km (see Figure 2.11) and any additional stretches necessary for salmonid spawning	The habitat for the species is currently unsuitable for the survival of adult mussels or the recruitment of juveniles. Mitigation must ensure that the plan or project does not further impact the habitat extent, including salmonid habitat, and does not compromise the improvement of the habitat so that the species has sufficiently widespread suitable habitat to maintain itself on a long-term basis Plan or project should not prevent or delay the recovery of the population to favourable condition as a minimum. The proposers should seek to demonstrate the value of their plan or project in this conservation objective and, where relevant, its contribution to restoring the habitat within the extents identified so as the population can maintain itself on a long-term basis.
Water Quality: Macroinvertebrate and phytobenthos	Restore water quality- macroinvertebrates: EQR greater than 0.90; phytobenthos: EQR greater than 0.93	Macroinvertebrates and phytobenthos are currently not achieving this objective target in the Blackwater River (Cork/Waterford) SAC (002170). Mitigation must ensure that the plan or project does not introduce further pressures on the water quality to ensure that condition of the habitat is not adversely affected to prevent the restoration of sufficient habitat in favourable condition to allow species to maintain itself on a long-term basis The Plan or project should not prevent or delay the recovery of the population to favourable condition. The proposers should demonstrate the value of their plan or project in this conservation objective and, and where relevant, its contribution to improve water quality where it is currently inadequate for the population to maintain itself on a long-term basis.
Substratum Quality: Filamentous Algae/Macrophytes	Restore substratum quality- filamentous algae: absent or trace (<5%)	The habitat must be almost free of filamentous algal growth and rooted macrophyte growth. Both block free exchange between the water column and the substrate and may also cause night time drops in oxygen at the water-sediment interface. In order to limit algal and macrophyte growth, the open water must be of high quality with very low nutrient concentrations therefore any plan or project must ensure that there is adequate mitigation to prevent increase in nutrient levels in the receiving waters and must not prevent the achievement of nutrient levels above those typically found in ultra-low oligotrophic waters. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve substratum quality where it is currently inadequate and resulting in filamentous algae and macrophytes that are above the target for favourable conservation status.
Substratum Quality: Sediment	Restore substratum quality- stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment	The lack of fine material in the river bed substrate allows for free water exchange between the open river and the substrate's interstitial water. This ensures that oxygen levels within the substrate do not fall below those of the open water. Therefore the mitigation for the plan or project must ensure that inorganic silt, organic peat and detritus, is not released to the

Conservation Objective	Target	Mitigation – Restore (maintain for distribution) Function
Suitable Habitat: Extent	Restore suitable habitat in more than 35km (see Figure 2.11) and any additional stretches necessary for salmonid spawning	The habitat for the species is currently unsuitable for the survival of adult mussels or the recruitment of juveniles. Mitigation must ensure that the plan or project does not further impact the habitat extent, including salmonid habitat, and does not compromise the improvement of the habitat so that the species has sufficiently widespread suitable habitat to maintain itself on a long-term basis Plan or project should not prevent or delay the recovery of the population to favourable condition as a minimum. The proposers should seek to demonstrate the value of their plan or project in this conservation objective and, where relevant, its contribution to restoring the habitat within the extents identified so as the population can maintain itself on a long-term basis.
Water Quality: Macroinvertebrate and phytobenthos	Restore water quality- macroinvertebrates: EQR greater than 0.90; phytobenthos: EQR greater than 0.93	Macroinvertebrates and phytobenthos are currently not achieving this objective target in the Blackwater River (Cork/Waterford) SAC (002170). Mitigation must ensure that the plan or project does not introduce further pressures on the water quality to ensure that condition of the habitat is not adversely affected to prevent the restoration of sufficient habitat in favourable condition to allow species to maintain itself on a long-term basis The Plan or project should not prevent or delay the recovery of the population to favourable condition. The proposers should demonstrate the value of their plan or project in this conservation objective and, and where relevant, its contribution to improve water quality where it is currently inadequate for the population to maintain itself on a long-term basis.
Substratum Quality: Filamentous Algae/Macrophytes	Restore substratum quality- filamentous algae: absent or trace (<5%)	The habitat must be almost free of filamentous algal growth and rooted macrophyte growth. Both block free exchange between the water column and the substrate and may also cause night time drops in oxygen at the water-sediment interface. In order to limit algal and macrophyte growth, the open water must be of high quality with very low nutrient concentrations therefore any plan or project must ensure that there is adequate mitigation to prevent increase in nutrient levels in the receiving waters and must not prevent the achievement of nutrient levels above those typically found in ultra-low oligotrophic waters. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve substratum quality where it is currently inadequate and resulting in filamentous algae and macrophytes that are above the target for favourable conservation status.
Substratum Quality: Sediment	Restore substratum quality- stable cobble and gravel substrate with very little fine material; no artificially elevated levels of fine sediment	The lack of fine material in the river bed substrate allows for free water exchange between the open river and the substrate's interstitial water. This ensures that oxygen levels within the substrate do not fall below those of the open water. Therefore the mitigation for the plan or project must ensure that inorganic silt, organic peat and detritus, is not released to the

Conservation Objective	Target	Mitigation – Restore (maintain for distribution) Function
		Margaritifera habitat, as all of these can block oxygen exchange. The proposers should demonstrate the value of their plan or project in this conservation objective and demonstrate their contribution to improve substratum quality through reducing erosion along pathways that lead to *Margaritifera* habitat and to improve the hydrological regime to improve the cleansing of the *Margaritifera* habitat of fine sediment.
Substratum Quality Oxygen availability	Restore to no more than 20% decline from water column to 5cm depth in substrate	The substrate must be free of inorganic silt, organic peat and detritus, as all of these can block oxygen exchange. Organic particles within the substrate further exacerbate the problem by consuming oxygen during the process of decomposition. Clean, coarse and stable substrate is essential for juvenile survival, as this species requires continuously high oxygen levels. It is therefore necessary to ensure that a plan or project does not significantly impact on the oxygen availability through the colmation of stream bed interstitial spaces due to the introduction of inorganic silt, organic peat and detritus that could lead to the further deterioration in the conservation status or the prevention of the restoration of conservation status. The proposers should demonstrate the value of their plan or project in this conservation objective and, where relevant, its contribution to improve oxygen availability where it is currently inadequate, i.e. to restore conditions to no more than 20% decline from water column to 5cm depth in substrate
Hydrological Regime: Flow variability	Restore appropriate hydrological regimes	To restore the habitat for the species, flow variability over the annual cycle must be such that: 1) high flows can wash fine sediments from the substratum; 2) high flows are not artificially increased so as to cause excessive scour of mussel habitat; 3) low flows do not exacerbate the deposition of fine sediment or growth of algae/macrophytes and 4) low flows do not cause stress to mussels in terms of exposure, water temperatures, food availability or aspects of the reproductive cycle Therefore a plan or project must not prevent or delay the recovery of the hydrological regime to that which is supportive of a fully functioning population and demonstrate their contribution to the restoration of the hydrological regime through measures to mitigate the impacts of artificial drainage, and other unsuitable land use change.
Host Fish	Maintain sufficient juvenile salmonids to host glochidial larvae	The presence of sufficient juvenile salmonids is essential to reach favourable conservation status. While the achievement of the habitat conditions described above are likely to also result in suitable habitat for salmonids, barriers to migration may exclude salmonids from previously occupied river stretches and therefore a proposed plan or project must consider these morphological pressures also and ensure that they do not prevent or delay the rehabilitation of the habitat where these pressures are present.

6.4 Operational stage mitigation measures

Providing specific details on the nature and type of mitigation measures required during the operational stage necessary to achieve the conservation objectives for *Margaritifera* populations in the Blackwater River (Cork/Waterford) SAC (002170) for every possible scenario is beyond the scope of this guidance, however some of the key principals around the major pressures that affect mussels are discussed.

6.4.1 Flow Regime

Flow regime is critical to sustainable *Margaritifera* populations and it is important to consider whether any ongoing management during the operational stage is needed in order to mitigate potential deterioration during the lifetime of the project.

Flow influences temperature and oxygen conditions, river bed substrate and mussel stability, the sediment interstitial environment of juvenile mussels, and mediates feeding and respiration of both adult and juvenile mussels, and reproduction.

While flow regime, including discharge volume and velocities, is a dynamic feature, it fluctuates within normal seasonal and annual limits. Many factors can influence the regime and result in changes beyond the prevailing norm that provide conditions for sustainable *Margaritifera* populations.

Margaritifera is adapted to stable habitat that is kept clean through high water velocities, even at low flows with low fine sediment infiltration not habitat that is subject to regular fine sediment infiltration (Moorkens and Killeen, 2014).

Impacts can be mitigated by avoiding land use change where it is currently positive, or any new management activities that result in deviation from normal flows. Changes that include removal of natural ecosystems such as blanket bog or wetlands as part of plans or projects are unacceptable. Even without drainage, agricultural intensification or changed vegetation leading to increased interception, evapotranspiration, and drier soils, such as densely planted trees or other crops profoundly influence system function with respect to surface water retention and release to the river. Lack of water storage and drying of soils leads to impaired near-bed velocity in dry periods, fragility and erosion of soils and subsequent loss of carbon to dissolved organic carbon in the aquatic environment downstream.

Drainage can act cumulatively with vegetation change to cause more rapid run-off resulting in higher peak flows and destructive water velocities, leading to dramatic sediment erosion and nutrient loss during high rainfall periods. Water storage capacity is lowered in drained areas, resulting in lowered water velocities during dry periods. *Margaritifera* requires a minimum flow velocity to avoid impairment of the mussels and their habitat (Moorkens & Killeen, 2014). Where drainage is contributing to existing unfavourable conservation status, further new drainage or improvement of existing drains should be avoided. In the case of existing drainage systems, sediment and nutrient pressures may be abated through the use of end of drain buffers or systems of drainage water diffusion before discharge to rivers, but impairment of water storage may not be sufficient to reverse where drainage is maintained.

In the case of residential, commercial or industrial development, sustainable drainage solutions such as permeable surfaces to facilitate infiltration, are unlikely to be successful and storage solutions with controlled release via hydrobrake structure or similar at greenfield rates will not restore the hydrological function required for a sustainable *Margaritifera* habitat. A more holistic approach is required. Peatland soils are the most important for habitat restoration. In mineral soils the development of SuDs that incorporates habitat typical of natural riparian landuse in *Margaritifera* mineral habitat should be incorporated, e.g. wet grassland. The project proponent should ensure that adequate investigation, including hydrological or hydraulic modelling, is undertaken to demonstrate that the hydrological function of the development site is not impacted and where previously impaired is enhanced as part of the proposed plan or project to facilitate restoration of habitat where required. Where ongoing management is needed, the mechanism must be put in place to ensure it will continue for the timescale of the project. This may include fenced off land with a grazing agreement with a local farmer, or a meadow and annual mow regime that is part of an ongoing Management Plan to be included in the handover to a housing estate management company, or to the local authority, if the estate is to be taken in charge.

6.4.2 Sedimentation

Sediment release to aquatic systems and eventual deposition on *Margaritifera* habitat is a common source of impact and *Margaritifera* habitat degradation. Identification of the sensitive areas that are liable to sediment erosion should precede any on-site activities so that such areas may be avoided in the first instance during the plan preparation or project design.

Operational Management Plans must include any efforts needed to prevent future sedimentation during the operational stage of a project. This may include e.g. a requirement to maintain fencing to prevent animal entry and trampling damage within the riparian zone and the watercourse itself.

6.4.3 Nutrients

Margaritifera occurs generally in oligotrophic waters. Any eutrophication of those water can have adverse impacts, and may arise due to application of fertilizers or discharges of nutrient rich effluents. As a first measure mitigation should avoid any further additions of nutrients to catchment waters upstream of *Margaritifera* populations. This may require changes in land use or land management methods. It could also mean siting facilities or their outfalls in locations where they cannot impact *Margaritifera*.

Assessment of projects such as agricultural schemes should choose separate approaches for the areas within the sub-basins of the three *Margaritifera* populations dominated by peat, where restoration of natural habitats should be prioritized. In the drier and more productive areas of the catchments, dominated by mineral soils, more intensive food production can be balanced with habitat conservation. Whole farm nutrient management plans are essential in *Margaritifera* catchments, including very careful management of the farm buildings and yard.

Where nutrients are applied to, or derive from terrestrial ecosystems, it may be possible to reduce the pressure at source. Firstly it must be demonstrated that soils are mineral rather than peaty in nature. The timing and conditions of fertilizer application are crucial in this regard, and careful attention must be paid to weather, topographic conditions and adequacy/effectiveness of buffer zones. Application should be based on established crop needs and occur at times when nutrient uptake is maximized.

Landscape features may help in abatement of impact on site. In mineral soils features such as vegetated buffer strips and riparian woodland can reduce nutrient export to the aquatic environment through curtailing discharge of enriched surface water, absorption and uptake of nutrients.

In the case of discharges to waters, elaborate on-site treatment of effluents, or off-site treatment and disposal may be required to adequately abate impacts on *Margaritifera* receiving waters. Consents, licences, or permits for any operational discharges must adequately consider the needs of the *Margaritifera* and include environmental quality objectives that are compatible with *Margaritifera* conservation requirements. Guide values for a range of parameters are set out in the Favourable Conservation Table – Informative Annex of the CEN Guidance. It is also essential that rigorous monitoring of such discharge consents is put in place to ensure compliance and prevent chronic or episodic impact on *Margaritifera*.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.4.4 Other Pollutants

Margaritifera is a species that is demanding of pristine water quality conditions, and is very sensitive to a range of pollutants. Toxic pollution can have very serious and long term effects on *Margaritifera* which, being benthic suspension feeders, are exposed to pollutants in surface water, sediment, interstitial water and through ingestion of filtered particles with sorbed contaminants. Substances such as pesticides, heavy metals, persistent organic pollutants, polychlorinated biphenyls (PCBs) and other priority dangerous substances have all been shown to be toxic to bivalve mussels that are less sensitive than the freshwater pearl mussel. Given the sensitivity of the pearl mussel to these substances, it is difficult to derive precise quantitative thresholds for impact prevention. Therefore, in the absence of adequate effluent treatment methods, a precautionary approach should be used, and discharges that may contain these substances must be avoided in watercourses inhabited by *Margaritifera*.

Iron ochre is a significant toxicity threat and enters the water following drainage, particularly of peat habitats. Therefore disturbance of peaty soils should be avoided by project design.

In the case of pesticides, or other toxic chemicals that may be used in *Margaritifera* catchments, the pressure impact must be reduced at source through avoidance of substance preparation, use or application in sensitive areas, or areas where loss to waters is possible. This could include treatment of trees in remote nurseries before planting, or movement of sheep to facilities outside catchment boundaries for dipping.

Impacts may be abated on site through strict adherence to protocols for safe storage, use and disposal of such chemicals.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.5 Construction Mitigation Measures

Once it has been established that the plan or project can be implemented without compromising conservation objectives of the *Margaritifera* population in the Blackwater River (Cork/Waterford) SAC (002170) it is necessary to demonstrate beyond reasonable scientific doubt that the project or plan can be constructed and decommissioned safely.

A positive conclusion resulting in permission for a project may include mitigation measures, as the design and method of construction of a project may be critical to the removal of residual risk from a permitted project. A complete design, including construction methods and mitigation measures are required in advance of planning in order to avoid lacunae during the assessment process, following a European Court of Justice ruling:

"[The Appropriate Assessment] cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned."

Case C-258/11Sweetman v. An Bord Pleanála [2013] ECR I – 0000 (11 April 2013)

6.5.1 Flow Regime

Flow regime is critical to sustainable *Margaritifera* populations and it is important to manage favourable flow conditions during the construction as well as operational stage.

Impacts can be mitigated by avoiding land use change where it is currently positive, or any new management activities that result in deviation from normal flows.

In the case of residential, commercial or industrial development, temporary dewatering may be needed to minimise the release of contaminated water from the site. As large sediment ponds can interfere with localised flow levels, particularly during low flow, and be hard to manage during very high rainfall, leading to spillage of contaminated water, the siting and use of such control measures needs to be carefully considered. The management of contaminated water is discussed in the next section, but it is important to be mindful that minimising the amount of contaminated water through restricting the amount of exposed soil at source at any one time assists in the management of water flows as well as sediment control.

6.5.2 Sedimentation

Sediment release to aquatic systems and eventual deposition on *Margaritifera* habitat is a common source of impact and *Margaritifera* habitat degradation. Identification of the sensitive areas that are liable to sediment erosion should precede any on-site activities so that such areas may be avoided in the first instance during the plan preparation or project design.

The construction phase of any project is a time of very high risk for sediment pollution. Construction Management Plans must provide very precise details of sediment mitigation measures, including the sequencing of soil disturbance and reinstatement before the next area is exposed, all within the triggers of the SOWOR system (see below).

Where activities that disturb soil are undertaken during the construction of a development, mitigation measures must seek to prevent sediment mobilization through the minimization of heavy machinery and site traffic, and the use of protective coverings such as mats or runners, and disturbance should be minimized in size and temporally, so that it can be undertaken only during dry conditions. Containment of any sediments at the source requires rigorous management, and mitigation measures must first seek to prevent sediment release to the aquatic zone where abatement becomes very difficult. Multiple barriers in sequence may be required to adequately reduce the impact at source. Sometimes three layers of silt fencing is needed, with

the first layer being dug into the soil (itself a risk of contamination), and the next layer, or two where needed, with geotextile folded at ground level rather than dug in.

In some circumstances sedimentation pressures may be abated by collection and treatment of contaminated waters. Sediment traps, or settlement lagoons from hard surfaces such as roads and car parks may provide some mitigation. Mechanical silt removal such as through "siltbusters" acting in parallel is also possible, but only where chemical coagulants are not used in combination with them. Heavy metals have long been known to be toxic to adult, juvenile and larval (glochidial) mussels (Wang et al., 2007; Markich, 2017; Khan, 2018). Coagulants from industrial plants and from sedimentation reduction processes used during construction changes the chemical and physical properties of water. However with regard to the level of abatement required to safeguard *Margaritifera*, their management and performance is critical. They are frequently of inadequate design, inappropriately sited, and may be poorly maintained or managed. In such circumstances mitigation measures for one purpose can become further sources of impact to downstream *Margaritifera*. Sufficient numbers of mechanical "siltbusters" should be stored on site to be rapidly employed when needed.

Even when such systems are performing optimally it is extremely difficult for them to produce an effluent of sufficient quality to allow discharge to *Margaritifera* catchment waters. Collection for on-site / offsite treatment, or discharge outside the catchment boundary may be preferable.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.5.3 Nutrients and other pollutants

Margaritifera occurs generally in oligotrophic waters. Any eutrophication of those water can have adverse impacts, and may arise due to application of fertilizers or discharges of nutrient rich effluents. As a first measure mitigation should avoid any further additions of nutrients to catchment waters upstream of *Margaritifera* populations. This may require changes in land use or land management methods. It could also mean siting facilities or their outfalls in locations where they cannot impact *Margaritifera*.

The nutrient levels of soils to be disturbed should be measured during ground investigations in order to determine the risk of nutrient pollution moving into contaminated water. If high levels of nutrients or other pollutants are found, it may be necessary to restrict further the level of exposed soil, or, depending on the hazard level, remove contaminated soil off the catchment.

Iron ochre is a significant toxicity threat and enters the water following drainage, particularly of peat habitats. Disturbance of peaty soils should be avoided by project design. They are very difficult to mitigate on site during a construction process. If iron ochre becomes exposed, it may be necessary to restrict the level of exposed soil in its vicinity and remove contaminated soil off the catchment.

At the end of the construction process, a balance must be found that restores vegetation to soil that has by necessity been exposed. This can include rapid seeding of bare soil with grass seed and fertilizer. However, the balance should favour the most natural type of habitat and minimize the level of artificial vegetation, with no seeding or fertiliser within the riparian zone. An ideal riparian buffer would be wet meadow. In peaty environments open rushy meadows provide good flood zones. In mineral environments mixed floral meadow would be positive in potential flood plains. In mineral environment riparian areas with higher river banks, some bankside trees can be planted to increase bank stability.

Abatement of impact at the receptor i.e. *Margaritifera*, is not a feasible strategy.

6.5.4 Mitigation measure guidance documents

Many guidance documents and standards have been written for the management of water protection during construction. These can also be used depending on both the level of risk of the project, and whether the measures are sufficient to meet with the demanding requirements of *Margaritifera*. For example, in high quality *Margaritifera* waters, suspended solids are below the level of detection, whereas there is a standard of less than 25 $mg.l^{-1}$ required for salmonid water, so extreme caution is needed in employing mitigation measures in a *Margaritifera* environment. The following documents are examples of mitigation guidance and include the requirements for best practice and adherence to the following relevant Irish guidelines and recognised international guidelines:

- CIRIA Report C532 Control of Water Pollution from Construction Sites;
- CIRIA Report C649 Control of Water Pollution from Linear Construction Projects. Site Guide.

- CIRIA Handbook C651 Environmental Good Practice on site checklist
- CIRIA Report C692 Environmental Good Practice on site 3rd Edition
- Netregs Guidance for Pollution Prevention series (GPP), in relation to a variety of activities developed by the Scottish Environmental Agency (SEPA), Natural Resource Wales (NRW) and the Northern Ireland Environment Agency (NIEA);
  - GPP 1 Understanding your environmental responsibilities – good environmental practices
  - GPP2: Above Ground oil storage tanks
  - GPP3: Use and design of oil separators in surface water drainage
  - GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer
  - GPP5: Works and maintenance in or near water
  - GPP6: Working at construction and demolition sites
  - GPP8: Safe Storage and disposal of used oils
  - GPP13: Vehicle washing and cleaning
  - GPP20: Dewatering underground ducts and chambers
  - GPP21: Pollution incident response planning
  - GPP22: Dealing with spills
  - GPP 26 Safe storage – drums and intermediate bulk containers
  - GPP 27 Installation, decommissioning and removal of underground storage tanks
- Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (Inland Fisheries Ireland, 2016);

6.6 Construction organisation

6.6.1 Environmental Operating Plan (EOP) / Environmental Management Plan (EMP)

The EOP or EMP is a document that outlines procedures for the delivery of environmental mitigation measures and for addressing general day-to-day environmental issues that can arise during the construction phase of a project.

There are generally four categories of EMPs during the lifetime of the project, depending on how many teams are operating the project and whether it falls into very distinct stages. The first would be the Advanced Works EMP, if there is to be advanced works such as levelling a site or clearing an old building. The Construction EMP covers the Construction Stage. Then there is the operational phase EMP and the decommissioning phase EMP.

Where a planning permission requires the fulfilment of environmental mitigation measures or restrictions during any of these phases, an EMP is required.

6.6.2 Construction Environmental Management Plan

Depending on the scale and complexity of a Project a suite of initial Construction Environmental Management Plans (CEMP) can be prepared for the construction phase of a Project and are presented below. They set out the minimum requirements that must be met in relation to management of the environmental aspects that could potentially be impacted by a project. These CEMPs will be finalised as required prior to the commencement of development and will incorporate the mitigation measures outlined in the documentation submitted with the application for permission, and will include any additional requirements pursuant to conditions attached to statutory consents. In addition, regular audits of the CEMP should be

undertaken during the construction phase of the works by a suitably qualified employers representative, e.g. Ecological Clerk of Works.

- Construction Traffic Management Plan (CTMP)
- Invasive Alien Species Management Plan
- Construction Waste Management Plan
- Noise Management Plan
- Dust & Odour Management Plan
- Marine Mammals Management Plan
- Birds and Marine Ecology Management Plan
- Water Quality Management Plan
- Pollution Incident Response Plan

The EMP must outline the environmental risks, the environmental commitments, the mitigation measures, roles and responsibilities, timescales and cost of mitigation.

The CEMP should include site preparation works, site compound details (including preparation, management and restoration), fencing, ground protection, silt fencing – number of layers, dug in or folded, temporary ponds, siltbusters in constant operation and on standby, concrete pouring details and management, emergency responses and all names and numbers of emergency contacts. All Method Statements for construction items must be included and transferred to the SOWOR.

Pollution mitigation for the control of pollution from machinery should include no refuelling within 50m of a watercourse, all machinery to have an on-board spill kit, all machinery to be checked on a daily basis prior to works, and to be free from hydrocarbon leaks, a hydrocarbon oil boom to be available at all times onsite with trained staff available for its deployment, and any generators to be on a hydrocarbon mat at all times. Any chemicals must be stored according to Control of Substances Hazardous to Health Regulations (COSSH) at least 50m away from aquatic environments within the safety of the site compound.

The CEMP should include a monitoring schedule with responsible persons and data management and responses to agreed elevated levels clearly defined. Construction within a *Margaritifera* environment is equivalent to an emergency response in a less sensitive area, so very detailed turbidity and water quality monitoring regime is needed. This also benefits the construction team and the developer, as they then cannot be blamed for pollution events that have not been caused by their construction programme.

6.6.3 Roles and responsibilities

One of the most critical aspects of the EMP is the handover of knowledge from the design team and the consultants that have brought the design through the planning phase, to the construction team, who may never have come across *Margaritifera* before, and the Ecological Clerk of Works (ECoW), who may have had no input into the environmental assessment process of the project. This handover is a stage where misunderstandings may occur, and the necessity of specific restrictions may not be easily understood. Ideally, the design team may stay involved, perhaps as the Employer's Representative. However, the responsibility lies with the developer / employer, who must ensure the fulfilment of environmental commitments and planning conditions. It is better for the employer to make sure that the ECoW works directly to them rather than be part of the construction team, in order to provide a level of independence from the construction contractors.

The EMP should therefore start with a very clear diagram and description of all the employees working on that phase, and how they interact. Specific personnel should be nominated to be responsible for compliance and for communication, with regular meetings between the construction team representative, the employer's representative and the ECoW. Between them they must be clear in the location and extent of mitigation measures, the detailed method statements for different parts of the operation, their transfer to the SOWOR, and the triggers and timing of the SOWOR.

6.6.4 The management of the project construction through the Schedule of Works Operation Record (SOWOR) system

When a project has been granted permission, there are usually many planning conditions to ensure that all the mitigation measures proposed are undertaken. Demonstration of compliance with the planning permission, sometimes following extended monitoring of the mitigation measures, and sometimes with ongoing licencing requirements during the operational stage completes the process.

Given the requirements of the *Margaritifera* for near-pristine conditions of flow velocities, oligotrophic waters demonstrating a lack of nutrient pollution and clean, silt-free interstitial environments in riverbed gravels, a sub-catchment for the habitat supporting such an flagship species is considered to be the most difficult location to undertake a construction project. For this reason, a protocol has been developed and implemented by Evelyn Moorkens Associates (EMA) to manage project construction to include all the mitigation measures conditioned, and to maintain a spreadsheet of all work items that can be used for compliance reporting purposes. This protocol is known as the Schedule of Works Operation Record (SOWOR) system.

The main guidance document provides details on the SOWOR under the following headings:

1. The management of the project through the SOWOR system;
2. Triggers for the SOWOR;
3. Maintenance of the SOWOR.

The main guidance document should be consulted to gain an understanding of the level of management required during the construction stage of a project in the Munster Blackwater catchment to safely remove construction risk, improve of the knowledge base for future applications, and for construction companies to demonstrate that they are safe and reliable partners in good conservation practice.

It is in the interest of the employer and of the construction company to be able to demonstrate that mitigation measures are working. This is done through clear documentation of the SOWOR, and through physical data from upstream and downstream Sondes, Water quality testing, and hand held turbidity measurements undertaken by the ECoW.

6.7 Emergency Planning

By their very nature emergency situations occur without warning when they are least expected and in ways which have not been anticipated. Situations can build up with some little prior realisation, so called "Rising Tide" events, or they can happen suddenly and catastrophically without any warning, referred to as "Big Bang" events. Therefore preparation and planning are key elements of any response. Given the unpredictable nature of emergency incidents, it is absolutely essential that a thorough and comprehensive assessment of risk to *Margaritifera* populations is included at the plan or project development stage. Section 5 of this document provides details of where information on *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002107) can be found.

Some likely emergency response activities are considered below in relation to the key pressures that typically impact on *Margaritifera* and its habitat. Note that although activities are listed under specific pressures some may give rise to multiple pressures.

6.7.1 Sediment

Soil and stone, construction materials and demolition waste may be excavated and stored during an emergency incident. The temporary or permanent storage of such materials may lead to run off of sediment to ditches and watercourses and eventually be deposited on *Margaritifera* populations and habitat.

This material may also be contaminated with pollutants that are injurious to *Margaritifera*. Plans or Projects should consider the siting, appropriate containment and/or treatment of these materials.

In an emergency situation the use of vehicles and heavy machinery in or near watercourses may also release sediments to the aquatic zone and this should be avoided in an *Margaritifera* area where possible. If absolutely necessary for emergency vehicles to cross through a river or watercourse containing an *Margaritifera* population this should only take place at a single point, and if possible this point should be downstream of any areas where mussels are present.

Any in-stream works (such as excavation, dredging, temporary construction or bridge repairs) should only be carried out following consultation with the relevant agency responsible for *Margaritifera* protection.

6.7.2 Nutrients

Sites in *Margaritifera* catchments where nutrient materials are either manufactured or stored, or in constant use should be identified and their location held within the plan. A site specific plan for each site should be drawn up to prevent the loss of nutrients in the event of an emergency situation occurring. The storage of such materials in areas considered at risk of flooding should be avoided.

The designation of any site as a potential base of operation should avoid *Margaritifera* catchments if possible. Otherwise the site selection process should be determined at the planning stage and must take account of known locations of *Margaritifera* populations, the presence of existing infrastructure such as roads, parking, water and sewage treatment facilities. Sites close to rivers and streams should be avoided.

Sites requiring construction of temporary access roads or service provision should also be avoided. A risk analysis of each site should be carried out to identify if there is a need for any mitigating measures if the site is activated.

6.7.3 Hydrology

Any significant change to the quantity of water, or the velocity of flow in a *Margaritifera* watercourse, through pumping high volumes or redirection of waters, is likely to be damaging. The abstraction of large amounts of water to control and extinguish a fire, and the subsequent discharge of fire water (possibly heavily polluted) may lead to such changes. Sudden increases in flow rates, even if the water is unpolluted, can also be damaging through scouring, particularly if the discharge is directly into the section of a watercourse where a *Margaritifera* population is present. Emergency abstractions and discharges should be avoided in *Margaritifera* rivers if possible. If absolutely essential they should occur downstream of any areas where mussels are present.

Complete or partial blockage of river flow may occur due to events such as landslides or bridge collapse. Such events can have catastrophic consequences for *Margaritifera*. Equally the restoration of flow, if not undertaken in an appropriate and sensitive manner can be very destructive. The emergency response plan should consider measures for controlled restoration of natural flow in the watercourse while minimising sediment release and transport downstream through installation of appropriate filters and sediment barriers and careful use of machines such as diggers required in rectifying the bridge collapse or landslide etc. On-site supervision of the activity by an *Margaritifera* expert is required.

6.7.4 Pollutants

A diverse range of pollutants may be released during an emergency incident. The emergency response plan should consider the range of activities in *Margaritifera* catchments and compile a register of the significant potential pollutants and their locations. These may include stored heating and fuel oils, and pesticides, In addition the polluting potential of all chemicals, retardants etc. in regular use by emergency services should be assessed and appropriate measures for avoidance and mitigation of impact on *Margaritifera* detailed in the plan.

An inventory of suitable pollution prevention and remediation equipment for use in sensitive *Margaritifera* areas should be agreed with *Margaritifera* experts and included in the plan. This should include any equipment and materials held by the regulatory agencies and equipment and materials that may be sourced from commercial suppliers. Typical examples include filter media designed to prevent sediment run off over land in the form of sediment curtains; filter media designed to inhibit sediment discharges from pipes or to be installed in river beds to trap sediment; temporary storage tanks which are readily transported and erected on site; oil pollution booms, skimmers etc.

6.7.5 Monitoring

During an incident, particularly a 'big bang' event or an event of short duration, it may be impracticable or impossible to monitor environmental conditions to assess potential impact on *Margaritifera*. However, as soon as it is safe to do so an assessment of the condition of the *Margaritifera* populations and habitat within the event area should be made by a qualified person.

In circumstances where incidents continue for days or a more protracted period, then ongoing risk assessment of threat to *Margaritifera* should be informed by strategic monitoring. Monitoring should continue for a timescale that reflects the risk period to the *Margaritifera* population, including the period post standdown and any rehabilitation works as necessary. Discussions with the conservation agency will guide the monitoring programme and the attributes that should be recorded. Some elements of the programme may be undertaken by the emergency response agencies, but other elements require specific *Margaritifera* expertise and should be undertaken by the relevant statutory agency with responsibility for *Margaritifera* protection and conservation.

The aim of monitoring is to alert personnel to any increase in threat to *Margaritifera* so that timely mitigation may be deployed as appropriate, and to assess the effectiveness of mitigation already in place. Monitoring should include inspection and photographic records of potential pathways for pollutants to reach and impact on mussel populations. Proper monitoring with well documented results will aid in auditing and revising emergency response plans, and will inform best practice methodology and mitigation into the future.

Elements of a monitoring programme that should be considered during lengthy incidents and protracted *Margaritifera* risk periods, and based on assessment of risk, should include as appropriate the parameters in Table 6-2. However, due to the sensitivity of construction activities in a *Margaritifera* environment, monitoring is already likely to be at these levels.

Table 6-2: Monitoring programme in emergency situations

Attribute	Monitoring needed	Frequency
Weather forecast data from a reliable forecast service and actual onsite conditions.	To maintain a record of weather conditions that might exacerbate risk factors and result in impact to *Margaritifera* materialising.	At least twice daily
Mitigation measures integrity checks	Regular documented checks of the integrity of any sediment fencing, weirs, booms, containment ponds etc. Integrity checks of machine routes and any exclusion zones. Time and location referenced photographic records are appropriate.	Repeatedly during the period of the incident as appropriate.
Stream Flow	To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess pollution and scouring potential.	At least weekly in protracted incidents.
Turbidity	To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess pollution by fine sediments.	Regularly each day with hand held meter, or constantly with automatic recorder in major protracted incidents.
Suspended Solids	To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess sediment pollution.	Weekly in protracted incidents.
Phosphorus	To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess nutrient pollution.	Weekly in protracted incidents, including rising flood conditions
Nitrogen	To be measured in drains and streams possibly affected by the incident, emergency response operations, or	Weekly in protracted incidents.

Attribute	Monitoring needed	Frequency
	rehabilitation works upstream of *Margaritifera* populations to assess nutrient pollution.	
Ammonia	To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess nutrient pollution.	Weekly in protracted incidents.
BOD/Dissolved Oxygen	To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess pollution by organic or oxygen depleting materials.	Weekly in protracted incidents.
pH	pH To be measured in drains and streams possibly affected by the incident, emergency response operations, or rehabilitation works upstream of *Margaritifera* populations to assess pollution by acidic or alkaline materials.	Weekly in protracted incidents.
Substrate Quality	Substrate quality Monitoring of river substrate type and condition, level of siltation (visual or redox) in *Margaritifera* habitat.	Monthly in protracted incidents.

6.8 Environmental Management System

In order to safeguard and protect the environment, the Projects can be operated and managed in accordance with a comprehensive Environmental Management System (EMS). The environmental management system

An EMS provides a comprehensive framework within which plan or project carries out its operations and activities to ensure the highest environmental standards are achieved in a sustainable manner. It is a systematic framework to manage the immediate and long term environmental impacts of the construction, operation and decommissioning of a project. Its ongoing implementation during the lifetime of project ensures that the Projects environmental footprint is minimised, the risk of pollution incidents is diminished, and ensures compliance with relevant environmental legislation.

The EMS is intended to facilitate effective and efficient management of the environmental aspects and any potential impacts of the project construction and operation. The project proponent can use the implementation of the EMS in relation to all its activities so as to prevent any significant adverse environmental effects on *Margaritifera* and its habitat.

The EMS documentation should set out the scope of the EMS which should include procedures for the management, maintenance and development of Project infrastructure: including roads, drainage system, selected utilities, buildings, and how operational activities are to be managed in the context of *Margaritifera* conservation.

Key relevant provisions of any Environmental Management System include:

- the requirement for all Contractors to be assessed/audited at procurement stage and throughout the project in accordance with predefined Environmental Performance in Procurement;
- awareness raising in relation to Project specific environmental issues to be provided to Contractors during the project;
- ongoing auditing and monitoring as required in the EMS, CEMP and other EMPs e.g. advance works;
- identification and documentation of environmental non-conformances and corrective actions/preventative actions;
- data storage and reporting as required by the EMS, CEMP and SOWOR.

7 CONTRIBUTING TO ONGOING KNOWLEDGE AND STANDARDS FOR *MARGARITIFERA* IN THE BLACKWATER RIVER (CORK WATERFORD) SAC

7.1 Reporting on any new knowledge of the population to NPWS

It is vital that we improve the evidence base for the distribution and status of *Margaritifera* populations within the Blackwater River (Cork/Waterford) SAC (002170). It is typically a condition of any licence for survey of *Margaritifera* issued by the NPWS that the survey results are returned to the NPWS using a standard form and spreadsheet. The returns should also include any reports on the survey, including distribution maps and assessments of habitat. The results of surveys of *Margaritifera* populations undertaken for plans or projects in the Blackwater River (Cork/Waterford) SAC (002170), and Ireland in general, are a valuable resource for supplementing information obtained as a result of monitoring surveys undertaken as part of Article 11 of the Habitat Directive.

7.2 Reporting of the SOWOR

There is a dearth of scientific data on the adequacy of mitigation measures for *Margaritifera*. It is essential to document all construction management methodologies and mitigation in order to provide an evidence-based set of methodologies and mitigation protocols to safeguard the ongoing restoration process into the future.

On this basis the SOWOR must be accurately filled in as a record of the scheme implementation and to record the mitigation measures applied and the success of same. This is also helpful to the contractor, as it can highlight pollution caused by a third party than could otherwise be blamed on the project works.

The SOWOR method of undertaking project construction and operation was developed to provide a standard of excellence in practice, documentation and compliance that can achieve the aim of safe removal of construction risk, improvement of the knowledge base for future applications, and for construction companies to demonstrate that they are safe and reliable partners in good conservation practice.

Planning conditions for projects within *Margaritifera* catchments should require a return of the completed SOWOR as part of the permitted compliance documents.

While compliance should include the return of a detailed account of the SOWOR to be reported to the planning authorities and NPWS, it is recommended that sufficient information from the SOWOR, including an anonymised summary of the successes and failures of mitigation measures is made publicly available to allow for continuous learning and for future projects to apply mitigation measures that have been proven to be effective elsewhere within the catchment.

7.3 Monitoring the success or failure of mitigation measures

When a project has been granted permission there are usually many planning conditions to ensure that all the mitigation measures proposed are undertaken. Demonstration of compliance with the planning permission, sometimes following extended monitoring of the mitigation measures, and sometimes with ongoing licencing requirements during the operational stage closes the loop and completes the process. The SOWOR offers an effective way to monitor whether the mitigation measures are effective and provides a mechanism to manage the risk to *Margaritifera* and, where necessary to abandon construction activities where significant risk is identified. The need to monitor the success or failure of mitigation measures for *Margaritifera* is not unique to the Blackwater River (Cork/Waterford) SAC (002170), and should be applied throughout all *Margaritifera* catchments in Ireland. Further detail is available in section 7.2 of the document "Guidance on Assessment and Construction Management in *Margaritifera* Catchments."

7.4 Feedback on success or failure of mitigation measures – contributing to the future of *Margaritifera*

It is vital that we improve the evidence base for the effectiveness of mitigation measures to protect or restore the conservation status of *Margaritifera*, from the impacts of development. The most effective way to achieve this is likely to be through a collaboration with the relevant industry, the bodies responsible for environmental protection and nature conservation and academia. For example, when a number of completed SOWORs have been returned, an analysis of mitigation methodologies and outcomes should be undertaken, perhaps as part of a postgraduate student project.

Ambitious targets to aim for must be set and whilst improving the evidence for the effectiveness of mitigation measures is a challenge, it is not an impossible one. In addition, an evidence base which demonstrates that something does not work, or might not work, is better than recommending mitigation measures without any evidence to support their application.

Options to share information and experiences about the effects of impacts, the success of implementing mitigation and monitoring programmes should be explored. A central repository providing an evidence base to inform design, construction methods statements and operational plans for plans and projects should be considered at a national, if not international scale.

Initiatives such as the SOWOR system which has been designed to implement the post-design, post-permission construction stage safely and to provide a monitoring record that can be used to inform future designs, method statements and mitigation effectiveness, could be accessed from this central repository and seek to protect or improve the conservation status of *Margaritifera* across Ireland and beyond. A web base platform is likely to be the most efficient way of achieving this goal and organisations such as CIEEM are already looking at the development of such as system to improve ecological assessment.

7.5 Opportunities to support the restoration of *Margaritifera* in the Blackwater River (Cork/Waterford) SAC (002170)

As part of the planning process within the Blackwater River (Cork/Waterford) SAC (002170), it will be necessary to demonstrate, at the very least, that a proposed plan or project will not prevent the restoration of *Margaritifera* within the SAC throughout its lifetime. However, developers and public authorities are encouraged to incorporate measures that will work towards the restoration of *Margaritifera* populations into plans and projects. Such measures will be largely context dependent based on the location of the project within the catchment and local hydrological and hydrogeological context. A good understanding of the expected natural habitat (i.e., in the absence of human influence) and the existing baseline is therefore vital to determine measures that can reasonably be undertaken. The threats and pressures affecting the Munster Blackwater, Allow and Licky *Margaritifera* populations within the Blackwater River (Cork/Waterford) SAC (002170) are outlined in Table 2-1.

Given the paucity of information on (1) the extent of *Margaritifera* within the Munster Blackwater in particular and (2) the effectiveness of mitigation measures for *Margaritifera*, a key opportunity to support restoration effort is the sharing of knowledge of *Margaritifera* populations with the NPWS and making the SOWOR publicly available (see section 7.2 above).

Consultation with the NPWS and *Margaritifera* experts is strongly advised to ensure that before they are undertaken, restoration actions for *Margaritifera* are both appropriate and likely to be effective. Effective restoration of *Margaritifera* populations requires a concerted effort at the river catchment level, and therefore local measures must be informed by restoration goals within the wider catchment.

Action programmes have been prepared as part of the Munster Blackwater, Allow and Licky Sub-Basin Management Plans. Priority measures identified specifically for the catchments can be found in the plans, which can be downloaded here: https://www.catchments.ie/download/freshwater-pearl-mussel-plans-2009-2015/. The measures are largely policy orientated and therefore not necessarily applicable to *projects* within the Munster Blackwater, Allow and Licky catchments but will be relevant for any plans. Targeted restoration measures can also be undertaken within the catchments, and these can be informed by the status of the *Margaritifera* population, soil drainage and the hydrogeological context within the catchment. Understanding how water, sediment and nutrients flow through the catchment can help to target specific measures that will have the greatest impact on restoring *Margaritifera*.

It is clear from section 4 above that hydrology/catchment wetness is a key driver in *Margaritifera* habitat in poorly draining/peat areas. Therefore, the restoration/ protection of bogs should be prioritised in these areas. This could be through the restoration of bog ecosystems through drain blocking, for example. Forest to bog restoration where open peat habitats were planted for forestry ("legacy forests") is also recommended as a hydrological restoration tool (Hermens et al., 2019). In freely draining areas, the protection/restoration of functional floodplains is vital, as most preferential flow habitat areas rely on an upstream and sometimes downstream flood zone that removes the scouring velocity potential of winter floods.

Phosphorus a key concern in declining *Margaritifera* populations as it acts as a key contributor to adverse eutrophication effects which consequently result in increased organic sedimentation, colmation, oxygen depletion in the substrate, pH fluctuations and changes in the fish community (Moorkens, 2020). Nutrient enrichment of surface waters from phosphate is a significant concern in poorly draining catchments, as unlike in freely draining areas where phosphate is attenuated, phosphate is prone to being washed into watercourses following heavy rainfall as overland or shallow subsurface flows in poorly draining areas. Therefore, addressing phosphorus pollution should be a priority in those parts of the Munster Blackwater, Allow and Licky catchments where the soil is poorly draining. This could be through remedying point sources of phosphate pollution (e.g., farmyard run-off and inadequate septic tank systems) or diffuse sources of phosphate such as land spreading of organic and inorganic fertilisers. Riparian buffer strips could be utilised where diffuse run off is an issue, as they can be effective in trapping sediment and nutrients, as well as other pollutants associated with surface water runoff such as pesticides (Ó hUallacháin, 2014). However, it is important to note that the efficiency of riparian buffer strips is influenced by numerous variables such as slope, topography, the width of the strip, soil type and land management. Ó hUallacháin (2014) recommends the use of remote sensing and digital elevation models to identify areas of overland flow and targeting appropriately designed and managed buffer zones to these areas (following consultation with affected landowners). This approach could prove to be more cost effective, increase farmer participation and ultimately work towards restoring *Margaritifera* to favourable conservation status in Ireland (Ó hUallacháin, 2014).

Nitrogen is damaging when it is associated with high temperatures and low oxygen, and when toxic nitrite and ammonia concentrations can manifest from nitrate. Pollution from animal and human waste can lead to unnaturally high BOD concentrations with significant negative effects on *Margaritifera* (Moorkens, 2020). Pollution from nitrate is more likely to be an issue in freely draining parts of the Munster Blackwater catchment. In freely draining areas, nitrate leaches readily from the soil into groundwater and associated surface water bodies. In poorly draining areas, nitrate denitrifies and typically does not cause impacts on groundwater. Therefore, addressing nitrate pollution should be a priority in freely draining parts of the Munster Blackwater, Allow and Licky catchments. This can be achieved in various ways, for example through the use of grass-clover systems on farms, reducing nitrate loading (e.g., reducing stocking density), or implementing an effective nutrient management plan. Ammonium, which typically comes from organic waste (farmyard run-off, untreated effluent from a septic tank, overland runoff following slurry application in poorly draining areas), is more of an issue for watercourses in poorly draining areas as the main pathway for this pollutant to waterbodies is via overland and near surface flows. The measures described above to address phosphate pollution would also serve to address ammonium pollution in poorly draining areas.

Sedimentation is a significant concern in *Margaritifera* catchments. It can arise from various sources, including land drainage, drainage maintenance, channel maintenance, livestock poaching, forestry clear-felling, quarries, peat extraction, construction sites etc. Land drainage and drainage maintenance is more common in poorly draining areas, and as such, sedimentation is likely to be a key concern in these catchments. However, given the high sensitivity of *Margaritifera* to sedimentation, and the myriad of sources, sedimentation of *Margaritifera* habitat is a common concern in both well-draining and poorly draining areas. Any measures that reduce sediment losses to rivers will work towards the restoration of *Margaritifera*. Such measures can include treating the issue at the source (e.g., cessation of peat extraction) or blocking pathways (e.g., introduction of riparian buffer strips, blocking drains, erecting fencing along watercourses to prevent livestock access).

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