

Hydropower Guidance Note HGN 2 Hydropower Flow standards

This guidance is not intended as a statement of law and should be read in combination with and in the context of the relevant enactments and EU obligations. Nothing in this guidance is intended to give NRW power to do anything that it would not otherwise have power to do or exercise any of its functions in a manner contrary to the provisions of any enactment or any EU obligation. In the event of any conflict between this guidance and enactments or EU obligations the latter takes precedence.

This Guidance Note has been prepared by NRW to provide applicants for impoundment and abstraction licences for the purpose of hydropower with information in relation to the mitigation standards for hydropower. Its contents may be updated periodically and applicants should ensure they read the most recent version, which is available on the NRW website.

1. Purpose of this guidance note

This guidance note will allow applicants to assess a proposed scheme and understand the type of operational condition that may be included in any licence issued by Natural Resources Wales.

The standards described here are intended as guidance only. Conclusions reached by using the flow chart and decision checklists in this guidance note are not binding, but designed to allow applicants a simple means of assessing their scheme.

Applications are assessed taking account of site specific factors and circumstances; for this reason licences may vary from the standards described in the flow charts and decision checklists.

Applicants should read the other Natural Resource Wales hydropower guidance notes to help them understand the legal, scientific and regulatory context for the standards described here.

2. Overview of approach

This guidance describes the process that applicants should follow to determine how much water is likely to be licensed for abstraction for hydroelectric power generation, and how that abstraction should be managed to reduce the risk of impact to in-stream and riparian ecology.

It has been developed so that a hydropower developer may determine initial mitigation requirements with a limited amount of site information. The checklists included in this section should be used first to assess whether a scheme is likely to be considered acceptable and if it is, to determine the indicative flow mitigation requirements.

Additional guidance is provided to describe how some site characteristics will allow alternative mitigation standards to be applied.

3. Abstraction standards for hydropower

Our strategies for licensing consumptive abstractions at a catchment scale are set out in our Catchment Abstraction Management Strategies (CAMS). The normal flow standards to which cumulative, consumptive abstractions are licensed by Natural Resources Wales in the CAMS are the Environmental Flow Indicators (EFIs).

Most abstractions for hydropower schemes are non-consumptive and result in a length of river reach in which flow is depleted, returning flow to the same watercourse at a downstream discharge point. For such non-consumptive abstractions, flow mitigation requirements that differ from the Environmental Flow Indicators can be applied provided that they are sufficient to protect the ecology of both the depleted reach and the wider river catchment.

Our approach to setting mitigation standards for hydropower abstractions where there is a depleted reach is based on two key principles of managing flows and river ecosystems. These are:

- i. protecting the ecology of depleted reaches by seeking to replicate the characteristics of the natural flow regime;
- ii. managing the spatial impact of individual schemes on the wider river ecosystem according to the size and gradient of the stream and the location of that stream within a river catchment.

Where a proposed hydropower scheme risks adversely affecting flow sensitive features of designated conservation sites Natura 2000 sites (SAC's, SPA's), Ramsar or Sites of Special Scientific Interest (SSSIs), or the supporting habitat of features of such sites, more stringent standards of mitigation will usually be required.

Some hydropower developments can disrupt the connectivity of river ecosystems by introducing hydrological barriers (flow depleted reaches) and/or physical barriers (impounding weirs). It is important that connectivity is maintained within a river ecosystem for free passage of species, nutrients and sediment along its course.

As a general rule hydropower developments in lower catchment streams and rivers present a higher risk of disrupting ecosystem connectivity and of having a greater spatial impact than schemes that are located in smaller, headwater tributaries. The need to maintain ecosystem connectivity is particularly important for the protection of migratory salmonids that require access along lower catchment rivers to reach spawning and nursery tributaries where they are present in upper reaches of catchments.

We reduce the risk of disrupting connectivity by setting appropriate flow mitigation standards and including measures to preserve fish passage.

4. Setting environmental flows

Abstraction regimes for hydropower that create a depleted reach will normally be required to protect three key characteristics of natural flow regimes to reduce the risk of impact on in-stream ecology. These are:

i. Protecting low flows

Setting a flow rate below which abstraction cannot occur is often described as a Hands off Flow (HoF). It ensures that low river flows will always be protected from abstraction. All hydropower abstraction licences will have a HoF.

ii. Protecting flow variability

An abstraction will normally be required to allow a proportion of the available flow to pass downstream of the intake at all times to mimic the river's natural flow variability within the depleted reach. The available flow is that available for abstraction between

the HoF and the maximum abstraction rate. The proportion abstracted is termed the 'percentage take (% take)'.

iii. Protecting high flows

A maximum rate of abstraction above which no additional flow may be abstracted will be set. This rate is typically expressed as a proportion of the mean flow (Q_{mean}). Having a maximum abstraction rate ensures that high flow rates necessary for in-channel geomorphological processes occur within the depleted reach.

5. How to use our guidance to determine an abstraction regime for hydropower

We have a two tier approach to determining the mitigation standards that will be required for a hydropower abstraction. A flow chart summarising the approach is provided in Figure 1 below.

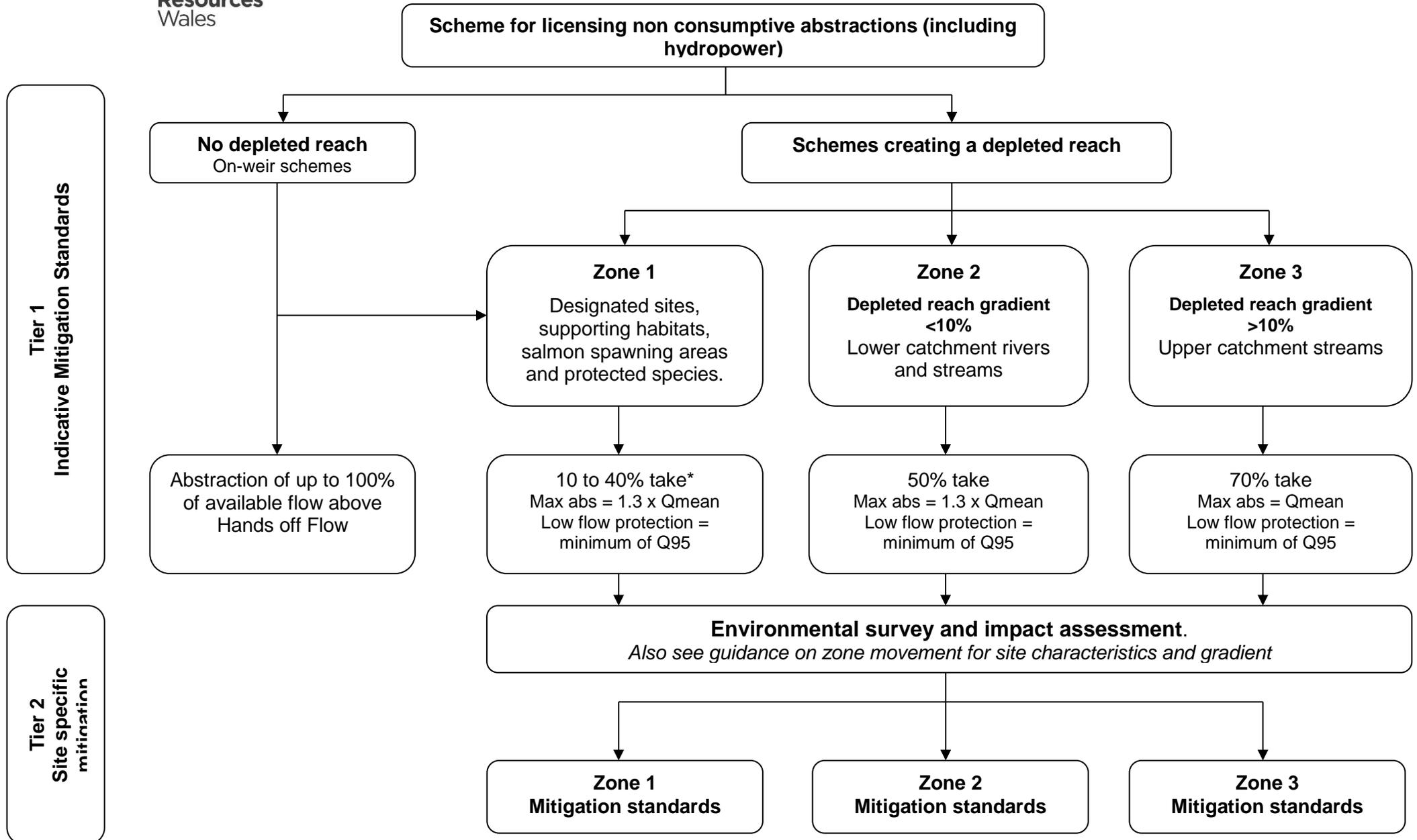


Figure 1: Flow chart for identifying indicative abstraction rates for hydropower schemes in Wales

* deviation above 40% can occur if developer provides evidence to conclude no adverse impact to the SAC feature

The tiers are:

Tier 1 Indicative mitigation:

Where a proposed hydropower scheme is 'on-weir' then the indicative mitigation requirements for schemes with no depleted reach should be applied.

Where a scheme will result in a depleted reach simple site characteristics are used to classify its location into one of three management zones to determine indicative mitigation requirements.

These zones are:

Zone 1: Designated Sites and supporting habitat of features of designated sites, salmon spawning areas, protected species and river dependent species (See note 1 below)

Zone 2: Lower catchment streams & rivers: sites where the average channel gradient of the depleted reach is less than 10% slope (<10%)

Zone 3 – Upper catchment streams: sites where the average channel gradient of the depleted reach is greater than 10% slope (>10%)

Average bedslope gradient of the depleted reach is used as a simple measure to collectively describe hydrological regime, location in the drainage network and channel geomorphology. A bed gradient of 10% and greater within the depleted reach is indicative of steeper, upland streams that are responsive to rainfall.

Tier 2 Site specific mitigation:

Particular physical or ecological characteristics of a proposed scheme and its depleted reach can sometimes demonstrate that alternative flow mitigation can be applied. Developers will need to provide appropriately detailed evidence to support alternative flow mitigation. More guidance on where alternative flow mitigation may be possible is provided in later sections of this note.

6. Selecting a management zone

The use of a two tiered approach will enable an applicant to independently identify an indicative abstraction regime from limited information about the site at an early stage in the development process. This may be prior to, or form part of the pre-application process. In

addition to a description of the scheme layout that contains locations of proposed points of abstraction and discharge, the information listed below will usually be necessary to determine the management zone in which a proposed site with depleted reach is located:

- Basic hydrological data including flow duration statistics;
- Topographic data to include gradient and length of the depleted reach;
- Catchment size at the point of abstraction;
- Whether the proposed scheme is located within a designated site, or within the hydrological catchment of a designated site and is likely to affect any of the notified features of such sites because of the presence of supporting habitat, or the sensitivity of the features to the flow or hydrological regime of that site;
- Whether the proposed scheme is likely to affect any protected species, and if so whether they are flow sensitive species, and the likely extent of those impacts;

Applicant checklists

The checklists below are designed to help applicants assess the likely outcome of their application to develop a hydropower scheme in Wales and identify indicative flow mitigation standards. Applicants should begin at the top of checklist A and use the lists in combination with the Guidance Notes referred to in the notes associated with each checklist.

The checklist conclusions are indicative only and may not always correspond with the final licence determination of NRW. Applications will be individually assessed and determined by NRW.

Checklist A: All schemes			
		Yes	No
1	Is the scheme sited: (see Note 1) (a) within a designated site or within the hydrological catchment of a designated site? (b) within Supporting Habitat for features of a designated site? (c) in a reach that supports a flow sensitive protected species?	If yes to <u>any</u>, go to Checklist B	If no to <u>all</u>, go to 2
2	Will the scheme incorporate a depleted reach beyond the immediate vicinity of the impounding weir?	Go to Checklist C	Go to 3
3	Will the scheme use an existing impounding weir that <i>cannot</i> be removed because it has a licensed or essential use? (see Note 2)	Go to 5	Go to 4
4	Will the scheme involve building a new impounding weir <i>OR</i> improving/using an existing weir that might be removed in the future? (see Note 3)	The scheme is unlikely to be licensed	Go to 5
5	If fish are present, will the scheme maintain or improve upstream and downstream fish and eel passage past the weir? (see Note 4)	Go to 6	The scheme is unlikely to be licensed
6	Will the scheme maintain the amenity value and ecology of the weir and weir pool where appropriate? (see Note 5)	Go to 7	The scheme is unlikely to be licensed
7	Will the scheme affect other licensed and established uses of the site (e.g. water abstraction, fisheries)? (see note 6)	Any conflicts should be resolved before considering an applicaton	Go to 8
8	In principle we are prepared to consider a formal application for the necessary licence(s). The abstraction rate may be up to 100% above the Hands Off Flow required to protect fish passage, weir pool ecology, amenity, and licensed and established uses. (see Note 7)		

Notes for Checklist A

Note 1: For the purpose of this guidance:

- Designated Sites include: Special Areas of Conservation (SACs), Special Protected Areas (SPAs), Ramsar wetland sites and Sites of Special Scientific Interest (SSSI). Designated sites in Wales include some rivers and water dependent wetland habitats.
- Supporting Habitats are defined as habitats that support the notified features of designated sites for all or part of their life cycle. This could include tributaries of designated river sites.
- Protected species are species that receive special legal protection under the Conservation of Habitats and Species Regulations 2010 (as amended) and Schedules 5 & 8 of the Wildlife and Countryside Act 1981 (as amended). Some protected species are sensitive to river flow or the construction of hydropower schemes.
- River dependent features are those terrestrial features which depend on rivers (e.g. Oceanic Woodlands near streams).

See Guidance Note: Designated Sites

Note 2: Removing weirs that interfere with the movement of fish or sediment is a priority for river ecosystem restoration in Wales. If a weir could otherwise be removed, hydropower development will compromise restoration efforts and will normally be inappropriate. The criteria for a weir being removable are technical; current ownership restrictions or financial constraints may change in the future. Weirs that are listed heritage features or have licensed or essential uses (e.g. active water abstraction, protecting essential support/protection to infrastructure) are unlikely to be removable now or in the foreseeable future. Such weirs are thus preferred sites for hydropower development. For further information see the following guidance note: Weirs

Note 3: Weirs can affect river ecosystems by interfering with the movement of fish and sediment and altering channel morphology. Building new weirs and restoring weirs that could otherwise be removed could compromise river ecosystem restoration efforts; where this potential exists full account will be taken of it in determining an application. For further information see the following guidance notes: Weirs, Fish Passage, Geomorphology, and Water Framework Directive.

Note 4: If the weir is currently impassable to fish, we will, where technically feasible and financially proportionate, seek the inclusion of measures to allow fish passage. If the weir is currently passable to fish, we will seek measures to maintain or improve fish passage. For passable weirs where eel, salmon or sea trout are present, passage efficiency will

most often need to be maintained or improved. For further information see the following guidance notes: Fish Passage and Fish Screening.

Note 5: In some cases (e.g. heavily impounded lowland rivers), weir pools can provide rare/important habitats for fish and wildlife. In such cases we will seek the inclusion of measures in hydropower developments to maintain and/or enhance these features. See Guidance Note: Weir Pools.

Note 6: Before you consider submitting an application, talk with people who may be affected by your proposal, listen to what they have to say and take steps to address their concerns.

Note 7: The specific mitigation requirement will be determined based on site specific conditions, the Water Framework Directive status of the water body and adjacent/affected water bodies, and other uses of the site.

Checklist B: Schemes affecting the notified features of designated sites and the supporting habitats of such features or protected species (see Note 1).			
		Yes	No
1	Is the scheme likely to affect the notified features of a designated site or habitat that supports such features? (See Note 1 and 2)	Go to 2	Go to 3
2	Can it be demonstrated that the scheme will not affect the conservation objectives of the designated site(s) concerned? (See Note 3)	Go to 3	The scheme will not be licensed
3	Is the scheme likely to affect a protected species? (see section 'Zone 1' in this document)	Go to 4	Go to 5
4	Is the protected species flow sensitive? (see section 'Zone 1' in this document)	Go to 5	Go to Checklist A, question 2
5	In principle we are prepared to consider a formal application for the necessary licence(s).The indicative Zone 1 mitigation for a scheme with depleted reach is minimum low flow protection of Q95 , 10% to 40% abstraction of available flow and maximum abstraction of 1.3 x Q _{mean} . (see Note 4)		

Notes for Checklist B

Note 1: Designated river sites, their supporting habitat, river dependent features, and protected species receive higher levels of protection under European and UK legislation. The conditions and mitigation measures for hydropower development in these sites are thus more precautionary, and more detailed evidence is typically needed to allow assessment of risk. The applicant assumes the burden of demonstrating 'no harm'. See Note 1 of Checklist A and Guidance Note: Designated Sites.

Note 2: Supporting habitats are those tributaries or parts there of which contribute to site integrity. For species, this could include areas of salmon spawning and / or nursery habitat. For habitats, these are areas of habitat or that are important to the maintenance or recovery of downstream habitat, for example sediment sources.

Note 3: Hydropower development in SAC rivers will rarely be appropriate and any application should be carefully considered. In SAC rivers, particularly those for which a migratory fish species is a designated feature, building new weirs and using removable weirs should be avoided; any hydropower development should target existing weirs that cannot be removed. For schemes located in supporting habitats, the construction of new impounding weirs will only be acceptable if the applicant can clearly demonstrate that the scheme will not impact on current or future conservation objectives. See Guidance Note: Designated Sites.

Note 4: These indicative flow mitigation measures can be adjusted based on site specific considerations contingent on the applicant clearly demonstrating that the scheme will not unacceptably affect the current conservation objectives of the site/species.

Checklist C: Schemes with depleted reaches			
		Yes	No
1	Is the average channel gradient of the proposed depleted reach < 10%? (see Note 1)	Go to 2	Go to 7
2	Will the scheme use an existing impounding weir that <i>cannot</i> be removed because it has a licensed or essential use? (see Note 2)	Go to 3	Go to 4
3	If fish are present, will the scheme maintain or improve upstream and downstream fish and eel passage past the weir? (see note 3)	Go to 5	The scheme is unlikely to be licensed
4	Will the scheme involve building a new impounding weir on main river <i>OR</i> improving/using an existing weir that might be removed in the future? (see Note 2 and 7)	The scheme is unlikely to be licensed	Go to 5
5	Will the scheme maintain the amenity value and ecology of the weir and wier pool where appropriate? (see Note 5 in checklist A)	Go to 6	The scheme is unlikely to be licensed
6	Will the scheme conflict with other licensed and established uses of the site (e.g. water abstraction, fisheries)? (See note 5)	Any conflicts should be resolved before proceeding with your application	Go to 8
7	In high gradient channels (>10%), whether the scheme uses an existing impounding weir <i>OR</i> involves building a new impounding weir, will the scheme be located, designed and maintained so as to: 1. not interfere with the movement of fish and sediment, and 2. minimise the impacts of abstraction on the depleted reach? (see Note 6)	Go to 9	Work with NRW staff to redesign the scheme before proceeding with your application
8	In principle we are prepared to consider a formal application for the necessary licence(s). The indicative flow mitigation measures for low (<10%) gradient channels are: Hands off Flow = Q95, 50% take, maximum abstraction = 1.3 x Qmean. (see Note 6)		
9	In principle we are prepared to consider a formal application for the necessary licence(s). The indicative flow mitigation measures for high (>10%) gradient depleted reaches are: Hands off Flow = Q95, 70% take, maximum abstraction = Qmean. (see Note 6)		

Notes for Checklist C

Note 1: Channel gradient is the drop in elevation between two points divided by the stream length between those two points. A gradient of 10% is equivalent to a 10 metre drop over a length of 100m. As a guide, on 1:50,000 Ordnance Survey maps, a 10% slope is associated with a 2mm space between 10m contours as measured along the blue line of the river channel. Channel gradient may need to be measured in the field.

Note 2: Removing weirs that interfere with the movement of fish or sediment is a priority for river ecosystem restoration in Wales. If a weir could otherwise be removed, hydropower development will compromise restoration efforts and will normally be inappropriate. The criteria for a weir being removable are technical; current ownership restrictions or financial constraints may change in the future. Weirs that are listed heritage features or have licensed or essential uses (e.g. active water abstraction, protecting essential support/protection to infrastructure) are unlikely to be removable now or in the foreseeable future. Such weirs are thus preferred sites for hydropower development. See Guidance Note: Weirs, Guidance Note: Geomorphology.

Note 3: If the weir is currently impassable to fish, the scheme should, where technically feasible and financially proportionate, include measures to allow fish passage. If the weir is currently passable to fish, the scheme should maintain or improve fish passage. For passable weirs where eel, salmon or sea trout are present, passage efficiency will most often need to be maintained or improved. See Guidance Note: Fish Passage and Guidance Note: Fish Screening.

Note 4: In some cases (e.g. heavily impounded lowland rivers), weir pools can provide rare/important habitats for fish and wildlife. In such cases, hydropower development should aim to maintain and/or enhance these features. See Guidance Note: Weir Pools.

Note 5: Resolving conflicts with others who are affected by hydropower development may facilitate hydropower development by reducing the likelihood of objections and legal actions.

Note 6: High gradient channels are an example of where the use of otherwise removable weirs, and the construction of new weirs, may be acceptable. This is because such channels are often 'naturally fragmented' by falls and steep cascades AND the spatial impacts of such schemes on catchment scale processes are expected to be spatially limited. We encourage applicants to locate, design and maintain schemes so as to

minimise impacts (e.g. locating abstraction point weirs on natural falls and above tributary confluences). See Guidance Note: Fish Passage, Guidance Note: Weirs and Guidance Note: Geomorphology.

Note 7: Main rivers are defined in the Water Resources Act and are a statutory type of watercourse in Wales. Whilst they are usually larger streams and rivers, they can also include some smaller watercourses. Main rivers can be identified by reference to the relevant main river map and can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. Watercourses that do not form part of a 'main river' are defined as 'ordinary watercourses'. The definition of watercourse is quite broad and can be found in the Water Resources Act and the Land Drainage Act. Given the potential adverse effects on the environment – and the nature of these effects – we are unlikely to approve the construction of new weirs on lowland rivers without clear and specific justification. This will also apply to the reconstruction of weirs that have ceased to be serviceable and which have been identified as preventing the achievement of WFD objectives. We are unlikely to be able to grant licences in connection with applications for such schemes in designated sites and their supporting habitats.

7. Tier 1 Indicative Mitigation Requirements

7.1 Indicative mitigation standards for schemes with no depleted reaches

Hydropower schemes that are built on an existing weir or natural fall (such as a waterfall or steep cascade) and discharge turbine flow into the river channel at the toe of the weir or natural feature may not result in any depletion of flow in the downstream reach of river.

Some schemes, may use a leat to convey flow away from the weir and result in turbine flow being discharged into the river a distance from the toe of the weir or natural fall.

Where a scheme discharges into a ponded section of river that has a backwater to the toe of the weir or fall then it may be considered as having no depleted reach and the on-weir indicative mitigation standards set out below will usually be applied. Where the turbine flow is discharged downstream and the abstraction will result in a length of river in which there are reduced flows then the depleted reach mitigation requirements are applicable.

For schemes where there is no depleted reach the following indicative mitigation standards can be applied:

Table 1. Indicative mitigation for sites with no depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	Up to 100%	1.3 x Qmean

Notes:

- The level of low flow protection will be based on site specific requirements to support local ecology and amenity, such as the visual appearance of flow over the face of a weir or cascade. The minimum level of mitigation that we usually require is a Q95 flow.
- For schemes proposed within sites designated for nature conservation, higher levels of mitigation may be required if a scheme is considered acceptable.
- Q95 is a site specific flow duration statistic that describes a flow rate that is equalled or exceeded for 95 percent of the time in an average year. It represents a typical low summer flow.

- Available flow is that available for abstraction after flow requirements for amenity, low flow protection and fish passage have been fully met.
- Q_{mean} is the mean annual flow at a site.

7.2 Indicative mitigation standards for schemes with a depleted reach

The mitigation requirements are set to provide the amount of residual flow necessary to minimise the risk to in-stream ecology for a river type according to its nature conservation status, its location within a catchment and its catchment characteristics.

Zone 1 - Designated sites, supporting habitat, salmon spawning areas and protected species.

This zone includes sites that are recognised nationally and internationally for their importance for nature conservation and are afforded a high level of legal environmental protection. Wales has a number of sites that have been designated as an area protected for nature conservation. Where the notified features of protected sites are sensitive to changes in river flow, the mitigation requirements for schemes proposed in these areas are likely to be more stringent than for schemes that have no designation for nature conservation.

Designated site features that are sensitive to changes in flow include:

- Old sessile oakwoods with *Ilex* and *Blechnum*
- Western/Atlantic (oceanic) bryophyte assemblages
- Killarney fern *Trichomanes speciosum*
- Atlantic salmon *Salmo salar*
- Allis shad *Alosa alosa*
- Twaite shad *Alosa fallax*
- Sea lamprey *Petromyzon marinus*
- River lamprey *Lampetra fluviatilis*
- Brook lamprey *Lampetra planeri*
- Bullhead *Cottus gobio*
- Eel *Anguilla anguilla*
- Freshwater pearl mussel *Margaritifera margaritifera*
- White-clawed crayfish *Austropotamobius pallipes*
- Otter *Lutra lutra*
- Water vole *Arvicola terrestris*

Detailed maps of designated sites in Wales are currently available at:

<http://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/find-protected-areas-of-land-and-seas/designated-sites/?lang=en> and on the Welsh Government Geoportal Lle (<http://lle.gov.wales/home?lang=en>).

Applicants should refer to these maps to confirm whether their scheme is located within, or will affect flows or hydrological regimes within the boundaries of a designated site.

Information about the notified features of Natura 2000 sites (Special Areas of Conservation and Special Protection Areas) and Ramsar sites can be found on the JNCC website.

Applicants are also advised to refer to information about the features of SSSI's and additional information concerning Natura 2000 sites available on our website.

This includes citations explaining why SSSI's have been notified and the site management plans incorporating the conservation objectives for Natura 2000 sites.

Protected sites that may be notified for features sensitive to changes in flow are:

- Special Areas of Conservation (SACs)
- Special Protection Areas (SPAs)
- Ramsar sites
- Sites of Special Scientific Interest (SSSIs)
- WFD Water Bodies at High Ecological Status (HES) or Quality Elements at high status
- Geological Conservation Review (GCR) sites
- National Nature Reserves (NNRs)

Supporting habitats:

Supporting habitats are defined as habitats that support the notified features of designated sites for all or part of their life cycle, or provide food or shelter for such species.

Designated sites usually include the supporting habitats for the species or features for which they are notified. However mobile species of designated sites may make use of other supporting habitat outside the designated site boundary if there are no effective barriers limiting their movement to these areas.

Examples of notified mobile species commonly required to be considered by hydropower schemes in Wales include several fish species (Eg. salmon) and native white clawed crayfish.

Salmon spawning areas

Salmon spawning areas are usually located in reaches of low gradient river channel with accumulations of gravels and other fine sediments in which salmon are known to, or thought likely to use for spawning.

Protected species

Non-designated sites but where EU or UK protected species are present: e.g. native white-clawed crayfish, otter, water vole, Killarney fern and certain bryophytes and lichens.

For schemes in Zone 1 the following indicative mitigation standards will apply:

Table 2. Indicative mitigation for Zone 1 sites with depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	10 to 40%	1.3 x Qmean

Where flow sensitive protected species are present, a scheme will need to be able to operate in such a way so as to allow environmental conditions to be met that are consistent with the achievement of a site's conservation objectives or species' favourable conservation status.

We recommend that you talk to Natural Resources Wales early in the development process to establish if and how protected species will need to be taken into account in relation to a proposed scheme. Further survey work may be required to provide adequate information to allow us to determine the likely operational licence conditions to adequately safeguard these important features. Depending on the site specific situation, it is possible that mitigation measures will be able to address potential impacts and that alternative mitigation standards to those shown in the table above can be applied.

Zone 2 – Lower catchment streams and rivers - gradient less than 10%.

These are sites with an average depleted reach gradient less than 10%. These are typically shallow gradient rivers and streams that do not have specific protected site status. Hydropower development in this zone has the potential of a large spatial impact due to interruptions to longitudinal connectivity within a river ecosystem.

For schemes in Zone 2 the following indicative mitigation standards will apply:

Table 3. Indicative mitigation for Zone 2 sites with depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	50%	1.3 x Qmean

Zone 3 – Upper catchment streams and rivers - gradient greater than 10%.

These are typically steeper gradient, upland catchments where hydropower development will have a constrained spatial impact on longitudinal connectivity and river ecosystem structure and function.

For schemes in Zone 3 the following indicative mitigation standards will apply:

Table 4. Indicative mitigation for Zone 3 sites with depleted reach		
Low flow protection (Hands off Flow)	% take of available flow	Maximum abstraction rate
Minimum of Q95	70%	Qmean

8. Tier 2 Site Specific mitigation for all proposed schemes

Applicants should use the Tier 1 checklists in this guidance to identify the management zone in which a proposed scheme is located and establish indicative flow mitigation requirements.

The purpose of Tier 2 is to allow additional site information to be used for a more detailed assessment of environmental risk. This could mean that a scheme may move to an alternative management zone with subsequent application of that zones mitigation requirements. Additional topographic, ecological or geomorphological surveys and assessments will likely be needed to demonstrate that flow mitigation for a scheme will still be able to meet appropriate environmental standards.

In exceptional circumstances it may be appropriate for flow mitigation to be further tailored to meet specific environmental or operational conditions. Applicants are advised to discuss these requirements with NRW staff at the earliest opportunity in the application process.

Some important considerations of physical and environmental characteristics of a site that could support movement between zones are:

An understanding of the impacts of a hydropower scheme on the mechanisms by which changes in river flow affect protected flow sensitive species, features or habitat.

Catchment description in terms of gradient, contributing inflows and physical barriers

8.1 Schemes with the potential to be Supporting Habitat for a SAC

A scheme proposed in a river outside a protected site boundary but in continuity with a SAC notified for one or more flow sensitive mobile species, such as salmon, has the potential to be a Supporting Habitat. The scheme would, at a Tier 1 level, be initially categorised as being in Zone 1.

Where it can be shown that the site does not qualify as Supporting Habitat then the respective mitigation standards for Zones 2 and 3 would apply according to the gradient of the depleted reach and additional site specific characteristics.

In this case movement from Zone 1 will be based on an assessment of the site to confirm the absence of mobile SAC species or the habitat that can be reasonably considered to support them now or in the future.

Applicants should complete the assessment and submit it to NRW in support of a licence application. The assessment may be based on existing data where available and/or new site surveys for protected species and habitats. Applicants are advised to contact NRW at an early stage in the application process if they are seeking an alternative to the indicative

mitigation standards. Survey requirements and their specifications are set out in the supporting information notes (in preparation).

8.2 Schemes within a protected site - SACs and Supporting Habitat

Schemes proposed within a SAC notified for flow sensitive features, or affecting Supporting Habitat are subject to a Habitats Regulations Assessment (HRA) (see Hydropower Guidance Note 4 Designated sites for further information). Natural Resources Wales are responsible for completing the HRA.

Applicants will need to provide evidence to support the completion of an HRA. The HRA must conclude that a proposed hydropower scheme will not adversely affect the protected features that collectively are necessary to maintain the overall integrity of the SAC.

Applicants could be required to carry out environmental surveys and assess the impact of a proposed scheme on protected features.

Flow mitigation standards must not prevent the conservation objectives of the site from being achieved. These will typically be the indicative standards for Zone 1. In exceptional cases it will be possible for Zone 2 or Zone 3 mitigation standards to be applied where it can be shown that a scheme will not affect the flow sensitive features.

A scheme may only be permitted where NRW can conclude through the Habitats Regulations Assessment that the abstraction will not adversely affect the integrity of the SAC.

Sites of Special Scientific Interest

Where a scheme is proposed within a SSSI, the indicative mitigation standards for Zone 1 apply.

Applicants can seek to deviate from Zone 1 standards when evidence is provided demonstrating that the operation of a proposed hydropower scheme will have a low risk of impact on protected features of the site. Applicants will need to undertake environmental surveys and an impact assessment to demonstrate this. Applicants are also advised to contact NRW at an early stage in the application process to confirm survey and assessment requirements.

Non SAC protected species outside a designated site

Hydropower scheme development is likely to have greatest risk of impact on otters and water vole during the construction phase. Applicants will be advised on survey requirements for these species in this context.

The mitigation standards for management zones will normally be adequate for the protection of water voles and otters. NRW will advise applicants at the pre-application stage if higher standards of mitigation for these species are required.

Native white-clawed crayfish are restricted to catchments in mid and south Wales where water quality and other factors are suitable for their survival, with particularly important populations in the River Wye and other rivers on the Welsh borders. NRW staff will advise whether developers will need to undertake surveys based on the location of a proposed scheme and the likelihood of crayfish being present.

NRW considers Zone 1 mitigation standards to be the appropriate protection for crayfish where they are shown to be present.

8.3 Zone movement according to site characteristics of gradient, contributing inflows and physical barriers

In some instances a proposed scheme may have a depleted reach gradient of less than 10%, initially qualifying for Zone 2 flow mitigation, but where physical or ecological characteristics of the site can be used to show that it may be acceptable for Zone 3 mitigation to be applied.

Principle site characteristics are detailed below.

9. Zone movement according to site characteristics of gradient, contributing inflows and physical barriers

In some instances a proposed scheme may have a depleted reach gradient of less than 10%, initially qualifying for Zone 2 flow mitigation, but where physical or ecological characteristics of the site can be used to show that it may be acceptable for Zone 3 mitigation to be applied.

Principle site characteristics are detailed below.

Gradient

Channel bed gradient has been used as a measure to define the location of a depleted reach within a catchment and describe its likely hydrological and geomorphological characteristics. It is calculated by dividing the difference in elevation between the points of abstraction and discharge by the length of the river channel to provide an average channel gradient for the depleted reach.

A 10% gradient is used as a threshold to categorise catchment types. Schemes with bed gradients greater than 10% typically identify steeper, headwater catchments that are responsive to rainfall and have flashy, upland hydrological and higher energy geomorphological regimes (Zone 3 Upper catchments). Sites with gradients less than 10% are more likely to describe lower catchment streams and rivers that have a larger upstream catchment, are less responsive to rainfall and have a depositional geomorphological regime with finer bed materials (Zone 2 Lower catchments).

Our approach to licensing hydropower aims to reduce the risk of introducing physical and hydrological barriers that interrupt catchment connectivity in lower catchments and minimise spatial impact of hydropower development in upland catchments. We also recognise that abstraction for hydropower has proportionally less impact on flow variability in upland catchments with flashy hydrological regimes.

We will consider deviation of a Zone 2 scheme (depleted reach gradient <10%) to Zone 3 where it can be shown that the scheme can meet the principles of our approach. Where the depleted reach gradient is less than 10% the following combined characteristics of the site will be considered;

Responsive hydrological regime

The flow regime at the point of abstraction can be shown to have a flashy hydrological regime or where there is uncertainty in the site hydrology the upstream catchment can also be shown to have impermeable geology;

Upstream catchment characteristics

The average gradient of the principle channel in the catchment upstream of the point of abstraction is 10% or greater;

Upstream catchment size

The catchment upstream of the point of abstraction represents a headwater tributary and development of a scheme will not affect ecosystem connectivity within the river catchment.

Contributing inflows

Schemes must provide the indicative Zone mitigation as the minimum standard of environmental protection along the length of a depleted reach. Tributary inflows to a depleted reach may provide additional mitigation through the introduction of flow volume and variability.

Developers intending to incorporate tributary inflows into their mitigation proposals will be required to submit a hydrological assessment in support of a licence application. The hydrological assessment will demonstrate that the necessary environmental standards are being met along the course of the depleted reach.

Barriers

A scheme will not be permitted to create a barrier to migratory salmonids by reducing flows over an existing structure (natural or artificial) that is currently passable under the existing hydrological regime.

In contrast existing artificial barriers, such as bridge footings or old weirs, currently prevent migratory salmonids from accessing some upstream catchments. During the abstraction licence determination process we will have regard for such barriers and consider the likelihood of improvements to them to ease fish passage. Where we consider fish passage improvements are likely to be made in the future we may need to constrain the rates of abstraction for hydropower schemes proposed upstream.