Environment Agency

Review of Good Practice Guidelines for run-of-river hydropower schemes

Supplementary consultation on river flow and water abstraction standards

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

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Introduction

We are evaluating a range of options for future river flow and water abstraction standards for run-of-river hydropower.

Run of river schemes use the natural flow of a river, by either placing a turbine on an existing weir or diverting water to a powerhouse containing a turbine. This is a reliable and proven technology which converts the power from flowing rivers into electricity.

The Environment Agency currently licenses hydropower in England and Wales in relation to water abstraction, impoundment, fish passage and flood risk management.

It is our role to ensure that hydropower schemes include appropriate measures to protect the environment. We do this by ensuring good scheme design, by attaching conditions to the permits we issue and by monitoring compliance with those conditions.

If the environment is not protected, we will not allow a scheme to go ahead.

The Hydropower Good Practice Guidelines (GPG)

In August 2009 we published Hydropower Good Practice Guidelines, providing advice and technical guidance for designers and developers of low head hydropower schemes. This consultation document should be read alongside existing guidelines, available on our website, which will provide essential background and context for this consultation.

In 2011 we consulted on a review of the GPG to reflect operational experience from our regulation of hydropower schemes and to extend the guidance to cover both high and low head schemes.

We received a wide range of responses to the 2011 consultation and are taking account of them in preparing the revised guidance. You can view the closed consultation and our summary of the responses on our website at https://consult.environment-agency.gov.uk/portal/ho/br/gpg/review.

The purpose of this supplementary consultation is to gather further views on river flow and water abstraction standards. We are also considering options for how to introduce any changes to flow standards.

We will take account of the consultation responses when preparing the revised Hydropower Good Practice Guidelines, which we expect to publish later in 2013.

The position in Wales

From 1 April 2013, responsibility for licensing in Wales will transfer to Natural Resources Wales. The work undertaken to date on reviewing and amending the Good Practice Guidelines, as well as the responses to this consultation, will be available for use by Natural Resources Wales.

About this consultation

What we are consulting on

We are consulting on options for revised river flow and water abstraction standards for run-of-river hydropower developments, as part of the wider review of our Hydropower Good Practice Guidelines (GPG).

We are also seeking views on when any changes, if adopted, would be introduced within the permitting process.

This consultation document should be read alongside existing guidelines, available on our website, which provide essential background and context for this consultation.

Consultation overview

This consultation is in two parts. The first considers the revision of river flow and abstraction standards for hydropower. We set out four options. These are:

1. A development from current standards;
2. An ecological sensitivity scoring approach;
3. General standards for water abstraction; and
4. General abstraction standards (as 3 above), with some provision for modification.

From one or more of these we will develop a revised set of standards for guidance on run-of-river hydropower schemes.

The second part of the consultation considers arrangements for introducing revised standards to schemes in the process of being permitted or in development.

Why river flow and water abstraction standards are important

This section contains some contextual information on river flow and water abstraction standards, why they are important and how they are considered.

The legal framework

In determining any application for an abstraction or impoundment licence for a hydropower scheme, we are bound by a number of general and specific statutory duties, as well as the requirements of the Water Framework Directive.

Examples of general statutory duties include sections 4, 6, 7 and 39 of the Environment Act 1995. There are examples of specific statutory duties in sections 38, 39 and 40 of the Water Resources Act 1991. Other statutory duties are included in, among others:

- the Salmon and Freshwater Fisheries Act 1975
- the Eel Regulations 2009
- the Habitats and Birds Directives of the European Union, – applied through the Conservation of Habitats and Species Regulations 2010 (SI No. 2010/490), commonly known as the Habitats Regulations

Water Framework Directive

The Water Framework Directive (WFD) became part of domestic law in 2003 and is now a key part of overarching legislation which governs how we manage and protect the water environment. The aim of the WFD is to protect and improve the aquatic environment and it does this by requiring the assessment of the status of many components of aquatic ecosystems.

The main objectives of the WFD in relation to hydropower development are that new schemes:

- do not cause deterioration in ecological status, or in ecological potential for water bodies that have been designated as artificial or heavily modified
- do not prevent the achievement of good ecological status/potential – either on their own account, or in combination with other pressures.

The Environment Agency guidance for hydropower will be consistent with these objectives.

How hydropower affects the aquatic environment

The use of water for hydropower, if not carefully managed, can have significant impacts on the aquatic environment. Diverting water from a river through a channel or a pipeline

will reduce the flow in the main river (see Box 1). This can then have adverse effects on any fish present, on the ecology of the channel and may change the way that sediment moves down the river. In some rivers, such as upland streams, the ecology has evolved to respond to the 'flashy' nature of their flows. The variation in flow provides cues for fish, stimulating local movement, migration, feeding, downstream drift and other behaviour. Altering the natural pattern of flows can have a significant impact on the ecology.

Depleted reach

A depleted reach is the section of watercourse between the point where water is abstracted from the river and the point where it is returned.

Where water is diverted from the main river channel through a leat or a pipeline, the channel will have a depleted flow from the point of diversion to the point of re-connection.

If the main river is a fish migration route and the greater part of the flow passes through a leat, the fish may be attracted to the higher flows in the leat. If there is no fish pass, there could be significant delays in migration or, at worst, no upstream migration at all.

A lack of appropriate habitat for foraging, spawning and shelter may force fish that are resident within the depleted reach to move downstream.

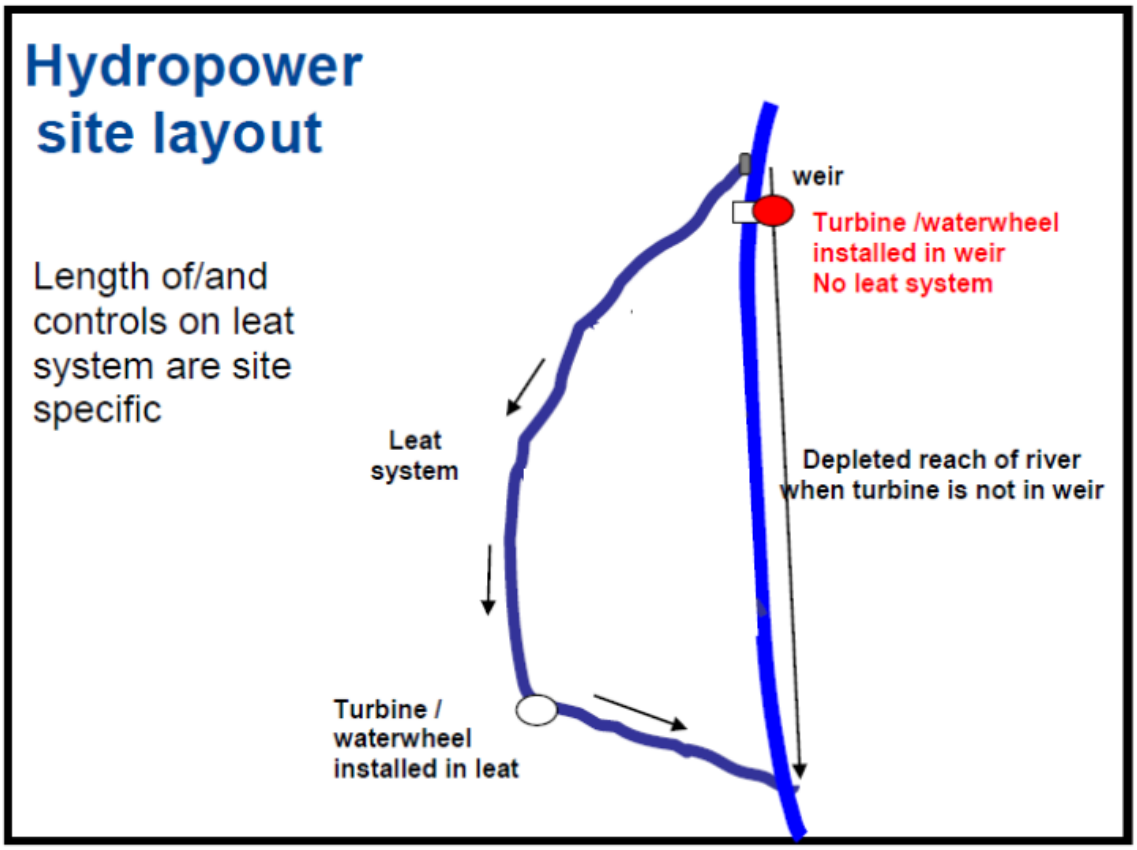
A depleted reach may also affect the ecology and hydromorphology within either the depleted reach or the river system as a whole. The effects will depend on the length of the depleted reach and its ecological sensitivity. The presence of a fishery and the significance of the site for fish passage are also important considerations.

Where a depleted reach is created as part of a hydropower scheme, there will be increased periods of low flows, often without any variability of flow. This may affect fish populations and other animal and plant life – in both rivers dominated by coarse fish and salmonids. These effects could prevent the site or associated river from meeting its environmental objectives, including inhibiting fish migration through the depleted reach.

Protected Areas

Hydropower schemes proposed in protected areas (for example, Special Areas of Conservation) may be subject to more protective standards. In England, these will be established on a site specific basis in discussion with Natural England. Natural Resources Wales will have responsibility for decision-making in Wales.

Box 1: Typical hydropower site layouts



Hydropower site layouts vary, but many of the main elements are shown Figure 1. A weir (impoundment) is present in almost all hydropower sites, and may provide the head drop of water on its own, or in conjunction with a fall in the river over a greater length.

A leat system will divert water from the main channel to some point where the fall in water is used to generate power. The leat system may have overflows to control the flow of water in the system.

The hydropower 'turbine' may be installed within or adjacent to the weir, or may be on the leat system.

A depleted reach occurs where water is diverted from the main channel through a leat system. Where the hydropower turbine is on the weir, the diverted reach is the weir itself. The impact of the hydropower proposals on flow and ecology in the depleted reach is one of the key issues in permitting hydropower schemes

Our current approach

The GPG contains detailed guidance on how we approach river flow and water abstraction standards for low head hydropower schemes.

For each proposed scheme, we suggest that the developer engages with us as soon as possible in the development process by completing our pre-application form. We appoint an Account Manager for each scheme to provide support as the details of the scheme are developed through to the formal application stage.

Within that pre-application stage, we ask that an Environmental Site Audit (ESA) checklist is completed. This helps to identify the potential environmental impacts of each scheme, covering the following issues:

- Water resources and hydromorphology
- Conservation
- Chemical and physio-chemical elements
- Fisheries and biodiversity
- Managing the risk of flood
- Navigation

An example of the checklist for water resources and hydromorphology is shown in Box 2.

When all the requirements of the scheme have been established, the developer must apply for a number of licences from us, covering some or all of the following:

- **Abstraction**

  We must agree the amount of water a scheme can take from the river to flow through a hydropower turbine.

- **Impoundment**

  Any new or raised weir will change the water levels and flows in the river by impounding more water above it. We will need to agree these changes.

- **Flood risk**

  Any works in or near rivers that have the potential to increase flood risk require consent. We have responsibility for this on main rivers. On other rivers and water courses this is the responsibility of the local authority. This will include both the construction works and the finished scheme.

- **Fish passage**

  For many schemes, we will require a fish pass to allow fish to pass safely up and down the river.

Details of the permissions required are available from our website.

For each proposed scheme, we will normally give particular weight to the following issues:

- the optimum use of available water
- the local and wider environmental effects – such effects may be positive or negative
- the assessment of flood risk and the proposals for mitigating that risk

- the impact on other water users – in terms of the effects on the protected rights of existing abstractors, on the lawful uses of water by others for agricultural, industrial, public supply or recreational purposes, and on requirements for fisheries, navigation or land drainage

- the contribution to sustainable development.

We consider the environmental effects of hydropower proposals by looking at the available evidence on how impoundments, turbines, flow modifications and flow diversions will affect river-based habitats and the associated plant and animal life. We also consider effects on the river hydromorphology and passage of sediment.

Decisions about ecological effects will need to reflect the approach that each piece of legislation takes to addressing uncertainty in the evidence.

Box 2: Extract from Form WR325 Environmental Site Audit checklist

If you tick a green box, you will not normally need to take any further action. If you tick a red box, the relevant note will give you guidance on the extra work you need to carry out.

1 Water resources and hydromorphology

We realise that you may not have enough information to answer all questions in section 1 at the moment. In this case, the notes to the questions will give you an indication of the information you may need to provide as your application progresses.

	Yes	No
Is the scheme 'high head' – that is more than 4m head? (See note 1a for more information.)		
Will the scheme return all the water abstracted (removed) to the watercourse it was taken from? (See note 1b for more information.)		
Will the scheme use any existing weir, channel, leat or other structure? (See note 1c for more information.)		
Will the scheme raise the height of, or change the operation of, an existing weir in a way that increases the length of impoundment (water held back behind a weir or dam)? (See note 1d for more information.)		
Will the scheme create a new impoundment? (See note 1e for more information.)		
Have you made an assessment of the existing hydrology of the site, which includes analysing how your scheme would affect the volume of water flow or the water level in all existing and proposed rivers, channels and so on? (See note 1f and question 2 in the hydroelectric-power pre-application form for more information.)		
Will the turbine be placed in a channel (or pipe for some high-head schemes) which is separate from the main watercourse? (See note 1g for more information.)		
Will the scheme cause the flow in a river channel to become depleted (that is, will the flow in the river channel be reduced)? This is known as a depleted reach. (See note 1h for more information.)		
Will the scheme create an extended depleted reach? (See note 1i for more information.)		
Will the scheme cause the flow at a weir to become depleted (that is, will the flow over a weir be reduced)? (See note 1j for more information.)		
Are planned changes in the flow in depleted reaches likely to cause a significant change to the patterns and rates of sediment transfer? (See note 1k for more information.)		
Are the river conditions around the proposed site likely to make the water more turbid (cloudy with suspended matter) during the operation of the scheme? (See note 1l for more information.)		
Is the proposed scheme in a water body that is currently at good ecological status or good ecological potential under the Water Framework Directive? (See note 1m for more information.)		
Do you have a right of access to the abstraction locations of the scheme? (See note 1n for more information.)		

Part 1 - Options for river flow and water abstraction standards

This section contains our consultation options for river flow and water abstraction standards for run-of-river hydropower.

In the previous consultation we invited comments on our current standards for low head hydropower schemes. The majority of those who responded suggested changes. Views were widely divergent between relaxation of the existing flow standards, retaining the existing standards with minor modifications or requiring greater safeguarding of river flows.

The previous consultation also included proposals for new guidance for high head hydropower schemes. Almost everyone who responded either criticised the proposals or suggested variations/amendments.

You can view the closed consultation and our summary of the responses here.

As a result of the comments received, we have decided to reconsider our river flow and water abstraction standards. In particular, we wish to address:

i. concern about apparent inconsistencies between our proposals for high head schemes and our approach to low head schemes; and

ii. the potential for adverse environmental impacts to certain species and ecosystems resulting from loss of flow variability in depleted reaches.

We have considered a range of approaches to address these concerns, from which we have developed four options for consultation, each of which we believe can provide an adequate level of environmental protection. While each of these options is workable and could be adopted in the revised GPG, they do not represent the only options available nor are they mutually exclusive. It would be possible, for example, to merge options, taking certain elements and combining them into a new option.

They are:

Option 1 - Development of current GPG standards, extending them to include high-head schemes.

This option builds on current GPG standards for low-head hydropower, using 'site sensitivity' as a criterion for flow limits in place of the current 'length of depleted reach'. It also modifies some other features of the flow table. For high-head schemes, as well as those in more sensitive river habitats, it introduces flow standards similar to those adopted by the Scottish Environment Protection Agency (SEPA).

Option 2 - An ecological sensitivity scoring assessment

This option would introduce, for all low and high head schemes, a site specific assessment of environmental sensitivity that we have used when permitting high head hydropower schemes in Wales. The flow allocation for any scheme is based on an environmental 'score' established from the assessment.

Option 3 - General standards for water abstraction ('CAMS/EFI')

This option would apply the Environment Agency's general abstraction licensing standards to hydropower. These are based on the Environmental Flow Indicators from Catchment Abstraction Management Strategies, (CAMS/EFI). The EFI is derived from Abstraction Sensitivity Bands (ASBs) which apply at water body level. This option would allow some flexibility to move between ASBs where this is can be justified by site specific features.

Option 4 - General abstraction standards (as in 3 above) but with provision for modification based on site specific features.

This option is an extension of option 3 but introduces some flexibility to move outside the ASBs based on site specific assessment of sensitivities.

The Environment Agency will take account of responses to this consultation in deciding the river flow and water abstraction guidance for hydropower in England, to be included in revised hydropower Good Practice Guidelines, which will be published later in 2013.

From 1 April 2013, responsibility for licensing in Wales will transfer to Natural Resources Wales. The work undertaken to date on reviewing and amending the Good Practice Guidelines, as well as the responses to this consultation, will be available for use by Natural Resources Wales.

Option 1 - Development and extension of existing Good Practice Guidelines (GPG) standards

The current GPG covers hydropower developments on existing weirs, up to approximately 4 metres in height. These are generally the sites of former mills, where the mill leat can be used as the intake channel for new turbines.

We have considered how we might develop the current hydropower guidance to include more recognition of specific environmental sensitivities of a site, whilst retaining the general approach of setting abstraction limits between a minimum 'Hands-Off Flow' (HOF) and an upper abstraction limit based around the average daily flow across a year (Qmean).

This option introduces two significant changes in approach from the current guidance, together with some modifications to flow criteria for various scenarios. These are:

1. Site sensitivity

The maximum and minimum flows are based on a new, broader assessment of site conditions and sensitivities than the current guidance, which uses the length of the depleted reach as a broad proxy for sensitivity. The flow thresholds for any site are based on four sensitivity bands (very low, low, medium and high), with the appropriate band for the site being determined after considering site specific factors, including those described in Table 1 of Annex A.

This option introduces variable flow rates above the HOF for certain more sensitive sites, through flow management or plant operating procedures.

The option extends the current guidance to include very high baseflow rivers. It also raises some of the permitted maximum abstraction levels. This greater flexibility can provide more water for hydropower generation provided that the site assessment does not identify unacceptable impacts or the need for additional mitigation measures.

Details of the permissible flows associated with these site characteristics are illustrated in Section 1 of Table 2 in Annex A.

2. High head/extended depleted reach schemes

There is increasing interest in developing new sites for hydropower, particularly ‘high head’ schemes. These schemes use large differences in height between the intake and the turbine (the head difference) to gain their energy for electrical generation. The water is normally diverted through a pipeline to a remote turbine house.

The current GPG does not cover these high head schemes.

The Scottish Environment Protection Agency (SEPA) provides guidance that reflects the predominance of high head schemes in Scotland. You can view the SEPA guidance at http://www.sepa.org.uk/water/hydropower.aspx. Their guidance shares the Environment Agency's approach of a protected minimum flow (HOF) and a maximum allowed abstraction rate. But it differs from the Environment Agency's current guidance by requiring some flow variability, above HOF, to avoid extended periods of low flow downstream of the intake.

In this option, we have suggested extending Environment Agency guidance to high head schemes by using a similar approach to SEPA's flow protection guidance. As this provides for flow variability above HOF, we also suggest using this approach for depleted reaches of higher sensitivity. These features are illustrated in Section 2 of Table 2 in Annex A.

Environmental and river flows outcomes

On weir schemes, no depleted reach (very low sensitivity)

For schemes where the turbine is located on the weir itself and the water is returned at the toe of the weir, the proposed river flow and water abstraction standard is similar to the first edition of the GPG.

However, the upper abstraction threshold is raised from Qmean to 1.3 x Qmean. The HOF is retained at Q95 (the flow exceeded 95% of the year), except for high baseflow rivers where the HOF is reduced to Q97 (the flow exceeded 97% of the year). There may be an additional volume of the natural flow retained for fish passage and screen bywash. If the weir pool is of high importance to the water body status or the wider catchment, a more protective allocation or flow distribution would be required.

Schemes with depleted reaches of low and medium sensitivity

For schemes with depleted reaches of low and medium sensitivity, the upper abstraction and HOF thresholds are similar to depleted reach standards (for up to 200m and over 200m) in the first edition of the GPG.

The scheme may be permitted to use 100% of the flow above the HOF up to a specified maximum if it can be demonstrated in a site specific assessment that this maintains sufficient environmental protection. In other cases, flow variability in the depleted reach will need to be maintained, either at a percentage of the naturalised flow upstream of any weir/off-take or through other management arrangements.

Schemes with extended depleted reaches or of high sensitivity

For schemes with extended depleted reaches or of high sensitivity, flow variability in the depleted reach will need to be maintained so that as the flow upstream increases, the proportion of the flow downstream above the HOF also increases. When the natural flow upstream would be Qmean, the flow downstream should be Q80 (the flow exceeded 80% of the year).

Option 2 - An ecological sensitivity scoring approach

The 'Water Abstraction Licensing using Ecological Scoring' (WALES) approach is a method of assessing the sensitivity of river ecology to changes in flow. It is used by the Environment Agency in Wales to determine an abstraction regime for upland, high head hydropower schemes. It can also be used for low head sites that create a depleted reach.

The amount of water authorised for abstraction is determined by the ecological sensitivity of the depleted reach, to protect residual and variable river flows.

This approach adopts a scoring system. It is based on historical monitoring data and ecological characterisation undertaken by the Environment Agency and one of our predecessor organisations, the National Rivers Authority. The scoring methodology is designed to categorise the relevant length of water body with a depleted reach into a band A, B, C, D or E (with A being the most sensitive).

Three elements are assessed in determining a total score, which may range from 3 to 48.

1. Physical characteristics
2. Fishery interest
3. Ecology

For each element, a score of 1 (least sensitive) to 16 (most sensitive) is assigned on the basis of a site specific assessment.

Method

The WALES assessment approach includes scoring the channel's physical characteristics, the fisheries interest and ecological sensitivity (macrophytes and invertebrates) found in the river type. The score is attributed to the feature that is most sensitive to changes in flow in each reach of the river.

The assessment would be undertaken by the applicant at either the pre-application or application stage and validated by the Environment Agency.

The physical character score is based on the sensitivity of the river type to abstraction. Rivers with greatly reduced wetted perimeters at low flows are most sensitive, whilst ditches or channels with minimal gradient are considered to be less sensitive.

The fisheries scoring system is based on the fish species present. Rivers that are considered to be salmonid (trout and salmon) habitat are regarded as most sensitive. Rivers with coarse fish present are moderately sensitive whilst rivers with only eel or sticklebacks would be considered least sensitive. An electric fishing survey may be required to determine the fish species present.

The ecological score is derived by carrying out a survey of the macrophyte species present and/or a survey of the invertebrate species present. The composition of species present reflects the nature and ecological sensitivity of a particular river which can be matched to a scoring system in WALES. Mosses and liverworts are particularly indicative of more sensitive rivers whilst species like duckweed or water-lily indicate less sensitive rivers. Invertebrates such as stoneflies or the golden-ringed dragonfly are typically indicators of sensitive rivers whilst ramshorn snails indicate less sensitivity. A macrophyte survey would normally have to be carried out by an expert, whilst a 'kick-net sample' would normally be conducted to sample the invertebrate species present.

The scores for the three elements are added to give an overall environmental score for the reach. This is then used to determine the appropriate abstraction regime for the site, to ensure flows in the depleted reach are adequate to protect the ecology and environment. Higher sensitivity sites will require greater levels of protection, with less water available for abstraction than in lower sensitivity sites.

The total score for the site provides the maximum abstraction rate above the HOF.

The summary of the scoring methodology is shown in Annex B.

Environmental and river flows outcomes

For all types of scheme

There will be a maximum abstraction limit of 1.3 x Qmean;

There will be minimum HOF of Q95.

Where the scheme creates a depleted reach

The volume of water allowed for diversion to a turbine will be based on a percentage of the naturalised flow above the HOF, determined by the ecological sensitivity scoring.

More detailed information on this flow and abstraction limits of this option are presented in Tables 3 to 6 of Annex B.

Option 3 - CAMS/EFI standards

We base most of our abstraction licensing procedures on Catchment Abstraction Management Strategies (CAMS)/Environmental Flow Indicator (EFI) standards. We use these to evaluate abstraction licence applications where additional flow pressure may compromise WFD objectives.

The CAMS/EFI standards incorporate the recommendations of the UK Technical Advisory Group for the Water Framework Directive (UK TAG), set out in Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive.

Those recommendations were developed from work by the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) in their project *WFD48 Development of Environmental Standards (Water Resources).* The reports from the project can be found at http://www.sniffer.org.uk/search?q=WFD48.

The UK TAG flow standards have recently been reviewed with only minor changes.

In this option for hydropower abstraction, the flow standards are set within a maximum flow that may be taken and a minimum flow (HOF) that must remain in the river channel. Between these upper and lower limits a proportion of the water may be taken, determined by the CAMS/EFI flow standards.

The volume of water allowed for diversion to a turbine will be based on a percentage of the naturalised flow above Q95 (or Q97 for high baseflow rivers), according to the assessment of the CAMS/EFI sensitivity of the depleted reach to flow modification.

The EFI standards assess the maximum abstraction volumes against three environmental sensitivity bands, known as Abstraction Sensitivity Bands (ASB). These are High (ASB3), Medium (ASB2) and Low (ASB1).

The ASBs have been developed to address the principal ecological sensitivities of rivers (physical habitat, macro invertebrates and fish) to the pressure from abstraction. While the three bands represent the ecological sensitivity of these river types to flow modification through abstraction, all three types contain biological and physical elements that require protection.

ASBs may be relevant to the management of hydropower where a depleted reach is created (either in low head leat systems or for high head schemes).

The proposed maximum take and HOF limits are shown in Table 7 of Annex C and the permitted take between these is shown as a percentage limit (% take).

Environmental and river flows outcomes

On weir schemes, no depleted reach

For in river, on-weir schemes where the water is returned at the toe of the weir, the proposed flow and abstraction standard will be similar to the first edition of the GPG. There is some greater flexibility in the thresholds, consistent with the need to protect flows over and close to the weir itself and provisions for safe fish passage.

The upper abstraction threshold is raised from Qmean to 1.3 x Qmean. The HOF is retained at Q95. There may be an additional volume of the natural flow retained for fish passage and screen bywash. If the weir pool is of high importance to the water body

status or the wider catchment, a more protective allocation or flow distribution would be required.

Schemes with depleted reaches (high and low head)

In this option, for hydropower schemes with a depleted reach:

- There will be set upper abstraction limits;
- There will be set HOF thresholds;
- Between the HOF and upper abstraction limit, the flows in the depleted reach will be maintained at a percentage of the naturalised flow upstream of any weir/off-take, consistent with the CAMS/EFI flow standards.
- The volume of water allowed for diversion to a turbine will be based on a percentage of the naturalised flow above Q95. This will be determined by an assessment of the sensitivity of the depleted reach to flow modification, using the Abstraction Sensitivity Bands (ASBs) of high, medium or low.

More detailed information on the river flow and water abstraction limits of this option are presented in Table 7 of Annex C, together with further information on EFI standards.

Option 4 - CAMS plus option

In this option, the default standards would be those in option 3 but there would be provision to deviate from the default standards on the basis of an ecological characterisation of the site.

CAMS are catchment wide assessments, therefore the environmental sensitivity assigned against the catchment assessment may, in some circumstances, not be appropriate to the depleted reach that the hydropower abstraction produces. If the applicant is able to provide evidence that the depleted reach is not as environmentally sensitive as the CAMS/WFD assessment, there may be scope to allow the scheme a greater amount of the flow.

This may allow the scheme to take a greater amount of the flow than the default standard for the low sensitivity band. The maximum take would be Qmean for any scheme creating a depleted reach, to preserve the natural variability of the higher flow ranges. The percentage take above the HOF could be somewhere between 45% and 100% of the maximum take depending on the level of environmental protection that would be deemed appropriate for the site.

Examples of such circumstances might include sites involving:

- Bare rock river channel
- Coastal streams
- Sites lacking in key ecological features
- No migratory fish species present or planned in reach
- Watercourses with no through fish passage requirements
- No fish spawning areas

Where these criteria can be proved with supporting evidence, adjustment away from the constraints of the Low, Medium or High Sensitivity Bands (ASB1, 2 and 3) could be proposed by the developer, for consideration by the Environment Agency.

Alternatively, a scoring system could be used, similar to the ecological sensitivity scoring approach outlined in Option 2.

Environmental and river flows outcomes

On weir schemes, no depleted reach

For in river, on-weir schemes where the water is returned at the toe of the weir, the proposed flow and abstraction standard will be similar to the first edition of the GPG. There is some greater flexibility in the thresholds, consistent with the need to protect flows over and close to the weir itself and provisions for safe fish passage.

The upper abstraction threshold is raised from Qmean to 1.3 x Qmean. The HOF is retained at Q95. There may be an additional volume of the natural flow retained for fish passage and screen bywash. If the weir pool is of high importance to the water body status or the wider catchment, a more protective allocation or flow distribution would be required.

Schemes with depleted reach (high and low head)

In this option, for hydropower schemes with a depleted reach:

- There will be set upper abstraction limits;
- There will be set HOF thresholds;
- Between the HOF and upper abstraction limit, the flows in the depleted reach will be maintained at a percentage of naturalised flow upstream of any weir/off-take. The percentage permitted may be greater than the limits of the ASBs if it is demonstrated that the depleted reach is less sensitive than any of the ASBs.

More detailed information on the use of EFI standards is included in Annex C.

Questions on Part 1 of the consultation

Consultation question 1

Please indicate which option you prefer:

- ☐ **Option 1**
- ☐ **Option 2**
- ☐ **Option 3**
- ☐ **Option 4**
- ☐ **A different option**

Please explain the reasons for your preference. If you selected a different option, please explain why and describe your alternative.

Consultation question 2

Would you like to make any suggestions for improving or amending any of the options?
If yes, please describe your proposals.

Consultation question 3

To help the Environment Agency and Natural Resources Wales to analyse the responses to this consultation, are you primarily interested in hydropower development in England, in Wales or both England and Wales?

- ☐ **England**
- ☐ **Wales**
- ☐ **Both**

Part 2 - Transitional arrangements

This section sets out how we propose to manage any transition to revised standards for river flow and water abstraction when we are determining applications for hydropower permits.

New Schemes

We will follow the Code of Practice on Guidance on Regulation. This recommends that changes normally become effective 12 weeks after publication of the guidance.

The revised standards will be the basis for our determination of the permit applications for new hydropower schemes which we receive and accept as valid from 12 weeks after publication of the revised GPG.

Our pre-application advice to developers will be based on the revised standards from the date of publication of the GPG.

Renewals

We will continue to renew time-limited licences for hydropower in accordance with our existing practice for renewal of water abstraction licences.

We will renew licences without changes to conditions where the abstraction is sustainable, where there is still a justification for the abstraction being licensed and where the water is used efficiently.

If there has been an unacceptable impact on the environment, we will inform the licence-holder that we intend to change the licence conditions and to apply the standards for river flow and abstraction for hydropower that are current at the time of renewal. We will give the licence holder notice of our intention to change conditions on the licence or to revoke the licence and we will provide evidence to support our decision.

Where abstraction licences are not time limited but there is evidence of unacceptable environmental impact from the hydropower abstraction, we may seek to make improvements under the Restoring Sustainable Abstraction (RSA) programme. In such cases compensation may be payable.

Question on Part 2 of the consultation

Consultation question 4

> **We will publish revised standards 12 weeks before they come into effect.**
>
> **Do you have any comments on this approach?**

Supporting information to consultation options

Annex A - Supporting information for Option 1

In this option, the maximum abstraction and flow rates will only be available if a range of environmental protection requirements have been fully addressed during the design stage.

Where risks are identified, mitigation measures will be required or an application will be refused.

TABLE 1 - Local Environmental Sensitivities to be addressed

Issue	Consideration
WFD water body status and objectives	A scheme must not cause deterioration in WFD status or prevent achievement of WFD objectives. We may require an assessment to confirm no impacts or to identify mitigation measures.
Managing flows for environmental protection	An environmental assessment must address potential risks, particularly to any depleted reach or fishery. This may identify modifications required to the proposed abstraction regime. Modifications may include: • Setting appropriate levels of maximum abstraction and low flow protection to provide flow variability; • Abstraction of a proportion of river flows; • Seasonal variations in maximum abstraction rates and hands off flows.
Fish passage	The majority of flow must be retained in the fish pass route for migratory fish.
Designated sites	A higher level of precaution is required in taking permitting decisions in relation to designated sites (SAC/ SPA/ RAMSAR/ SSSI). For this reason, flow criteria for these sites are typically more protective of the ecology and the general flow standards in these tables may not be appropriate. Flow criteria will be assessed according to the needs of the features of each designated site.

Table 2 - River flow and water abstraction standards for Option 1

Subject to addressing the environmental sensitivities of the site, the maximum abstraction and flow rates that would be permitted under this option are:

SECTION 1 – Development of standards from first edition of the GPG

Note to section 1:
The maximum abstraction rates and levels of low flow protection may need to be varied from the limits in this table to provide a variable residual flow solution where detailed environment assessments have shown this is necessary.

Environmental sensitivity	**River flow regime type**					
	Baseflow type *Q95/Qmean value*	Flashy river *Less than 0.1*		Medium / low baseflow *Between 0.1 & 0.2*	High base flow *From 0.2 up to 0.4*	Very high base flow *Above 0.4*
		Fish migration issues	No fish migration issues			
Very low e.g. No depleted reach	Maximum abstraction	1.3 x Qmean	1.3 x Qmean	1.3 x Qmean	1.3 x Qmean	1.3 x Qmean
	Hands-off flow	Q95	Q95	Q95	Q95	Q97
Low sensitivity	Maximum abstraction	Q40	Qmean	Qmean	Qmean	Qmean
	Hands-off flow	Q90	Q90	Q95	Q95	Q95
Medium sensitivity	Maximum abstraction	Q40	Qmean	Qmean	Qmean	Qmean
	Hands-off flow	Q85	Q85	Q90	Q95	Q95

SECTION 2 – Addition of proportional flow requirements for sites of high sensitivity

This is similar to part of the SEPA guidance for protection of flows, particularly for small, steep streams or those in degraded parts of the water environment. You can view the SEPA guidance at http://www.sepa.org.uk/water/hydropower.aspx.

High sensitivity and/or extended depleted reaches	Maximum abstraction	1.3 x Qmean	1.3 x Qmean	1.3 x Qmean	1.3 x Qmean	1.3 x Qmean
	Hands-off flow	Q90	Q95	Q95	Q95	Q95

Notes to section 2:

1. **Protection of flow variability**

   Periods where the flow exceeds the hands-off flow must be provided by designing the intake structure such that as the flow upstream increases, the proportion of flow (additional to the hands-off flow) passing downstream also increases. When the natural flow upstream would be Qmean, the flow downstream should be at least Q80.

2. **Protection of low flow**

   The hands off flow must be at least Q90 for sites with:

   - sites with catchments upstream of the tailrace < 10km2
   - sites where the wetted area is significantly reduced at flows below Q90

Annex B - Supporting information for Option 2

The tables below illustrate the approach to assessment of the three environmental elements in this option.

Table 3 – River flow and water abstraction standards for Option 2

The 3 scored elements are added together to provide the total score for the site, from which a permitted abstraction flow is derived.

Sensitivity band	Combined Environmental Score	Maximum instantaneous abstraction rate above the HOF (% of available flow)
A	41-48	40%
B	31-40	50%
C	21-30	60%
D	11-20	70%
E	10 or less	80 – 100%

HOF set to protect a residual flow of no less than Q95 Maximum abstraction rate of 1.3 x Qmean (Mean Flow)

Scores for individual elements

Table 4 - Physical elements

SCORE	DESCRIPTION
16	Rivers with greatly reduced wetted perimeter at low flows
15	Small, even gradient rivers with runs and shallows
14	Large, steep, and even gradient rivers dominated by runs and shallows
13	Waterfall/pool (upland) rivers or large rivers with fast flowing runs and deep pool/riffle sequences
12	Small often high gradient riffle-dominated rivers
11	Small pool/riffle, low gradient rivers with natural character
10	Large pool/riffle rivers
9	Semi-natural low gradient (usually also lowland source) rivers
8	High base flow rivers
7	Managed lowland rivers with good instream edge habitats and steeper gradient rivers with constrained banks
6	Winterbournes
5	Ditches with extensive shallows
4	Heavily managed low gradient rivers
3	Ponded/impounded rivers where edge and bank structure is semi-natural
2	Ditches/channels with minimal gradient
1	Rivers unnaturally ponded and/or with minimal habitat

Table 5 – Fisheries elements

SCORE	DESCRIPTION
16	Major salmonid spawning and/or nursery area
12	Adult salmonid residents
10	Adult salmonid passage and/or rheophile coarse fish - barbel grayling etc
8	Flowing water cyprinids - dace, chub, bleak, gudgeon etc
5	Slow/still water cyprinid fish - roach, bream, tench, carp etc
2	Poor coarse fishery
1	No fisheries interest, sticklebacks and eels only or no fish

Table 6 – Ecology elements

Examples of scoring for ecology elements

SCORE	DESCRIPTION
16	Riffle biota vulnerable to desiccation as wetted area is reduced – i.e. species sensitive to velocity, coarse substrate and high oxygen levels - such as certain dragonfly and stonefly larvae (e.g. Cordulagaster and Perlodidae) - and some mosses and liverworts requiring regular submergence or splashing (e.g. Scapania, Hygrohypnum) or species at margins needing high humidity (e.g. filmy fern, Hymenophyllum) OR Totally water-table/inundation dependent habitats adjacent to the river where abstraction would change summer water levels significantly enough to change the hydrological regime of the site (i.e. water levels not maintained by structures or natural features).
13	River biota dominated by species which thrive in fast/moderately flowing water such as crowfoot, mosses/liverworts (e.g. Fontinalis squamosa, Chilocyphus) range of stoneflies, (e.g. Perlidae and Leuctridae) mayflies (e.g. Heptagenidae and Ephemerellidae), Caddisflies (e.g. Goeridae and Rhyacophilidae), damselflies (e.g. Calopteryx virgo).
10	Variable and rich pool, slack, run and riffle biota with species dependent on clean gravels/pebbles and fast flows. River reaches with extensive marginal habitats dependent on water-logging, and not protected by structures, also included. Submerged dead-wood habitat and fauna noteworthy for the sub-catchment. Typical species are riffle beetles (Elmidae), Mayfly (Ephemerellidae) , caddisfly larvae (e.g. Goeridae and Limnephilidae) and pea mussels (Sphaeridae). Typical macrophytes are crowfoot, milfoil and variety of mosses. OR Riffle and other vulnerable habitats dominate but biological data are too limited to make assessment.
6	Very rich flora/fauna of sluggish/ponded river dominate, with few species indicating pollution or stress. Limited/nil sensitivity to reduce volumes provided level and water quality are maintained but given high score to protect the very best examples. Typical species include white water lily (Nymphaea alba), pollution sensitive pondweeds (e.g. Potomogeton lucens, shining pond weed and Potamogeton natans, broad-leaved pondweed) mayflies (e.g. Baetidae and Ephemeridae), Caddisflies (e.g. Limnephilidae) and alderflies (Stalls sp). OR riffles and more sensitive habitats where the present communities are poor but would improve if water quality and other factors were addressed.

3	Mixed community of species dominated by pond species or those thriving in slow-flowing water or high water quality. Typical species include fennel pondweed (Potamogeton pectinatus), Nuttall's ponddweed (Elodea nuttallii), Arrowhead (Sagittaria sagittifolia freshwater shrimps (Gammarus sp\ the mayfly (Ephemera danica) and various marginal beetles and bugs.
1	Assemblages very limited, containing virtually only pollution tolerant biota such as blood worms (Chironomidae), dominant blanketweed Cladophora sp). OR species thriving only in ponded conditions such as duckweed (Lemna), hornwort (Ceratophyllum) water boatmen (Conxidae) hog lice (Asellidae) and ramshorn snails (Planorbidae). Additional Weighting (1-6) for terrestrial SSSI wetland sites, riverine SSSIs' or designated/rare species which have specific habitat associations with areas most likely to be impacted by abstraction (i.e. fast flow. coarse substrates).

Annex C - Supporting information for Option 3

Table 7 - River flow and water abstraction standards for Option 3

	Schemes on weir with water returned to the toe of the weir
	All sensitivity bands (ASB1 – ASB3)
Hands off flow (HOF)	Q95
Maximum take	1.3 x Qmean
% take above HOF	100% minus fish pass, screen bywash and weir need

	Schemes with depleted reaches					
	High sensitivity ASB3		**Medium sensitivity ASB2**		**Low sensitivity ASB1**	
River type *Q95 / Qmean value*	Low & medium baseflow *Below 0.2*	High baseflow *0.2 & above*	Low & medium baseflow *Below 0.2*	High baseflow *0.2 & above*	Low & medium baseflow *Below 0.2*	High baseflow *0.2 & above*
Hands off flow (HOF)	Q95	Q97	Q95	Q97	Q95	Q97
Maximum take	1.3 x Qmean	Qmean	1.3 x Qmean		1.3 x Qmean	
% take above HOF	35%		40%		45%	

Notes:

A more protective allocation of flow distribution will be required if:

- The weir pool is of high importance to the water body status or wider catchment; or
- Fish passage is likely to be made worse by a reduction in flow over the weir.

The initial assessment of sensitivity will be provided by the Environment Agency. As for other abstractions, the initial assessment may be reviewed using scheme specific assessments carried out by the applicant. If a depleted reach does not, and is not

expected to have, features in the initially selected sensitivity band, then a lower appropriate sensitivity banding may be agreed.

The application of the Environmental Flow Indicator (EFI) to hydropower

We use the environmental flow indicator (EFI) to evaluate abstraction licence applications to indicate where additional flow pressure may compromise the WFD ecological status. If flows are greater than the EFI then we assume that, at the water body scale, the hydrological and morphological impacts of the abstraction will not cause deterioration of Good Ecological Status (GES). Local impacts must still be considered.

The EFI standards utilised in the CAMS and WFD process set the maximum volumes that can be licensed for abstraction, assessed against three environmental sensitivity bands, known as Abstraction Sensitivity Bands (ASB); namely High, Medium and Low. The EFI is derived from a naturalised flow dataset and the proportion of the flow that may be abstracted depends on both the flow and the environmental sensitivity of the river reach.

We will consider a small departure from the EFI where an applicant can demonstrate there are grounds for minor modification based on local, site specific circumstances.

In CAMS the HOF is used to protect flows above the EFI. However, hydropower abstractions tend to require high maximum abstraction rates (normally around Qmean). These rates, when modelled in CAMS, can result in the level of the HOF being set very high to protect the EFI, even though there could be some water available for hydropower abstraction below the high HOF.

To address this, we have assessed a range of combinations of the three main components of hydropower abstraction (HOF, maximum abstraction and percentage take above HOF) and compared these against the EFI using hydrographs and flow duration curves to achieve a close statistical match. The results of the analysis formed the basis of Table 7.

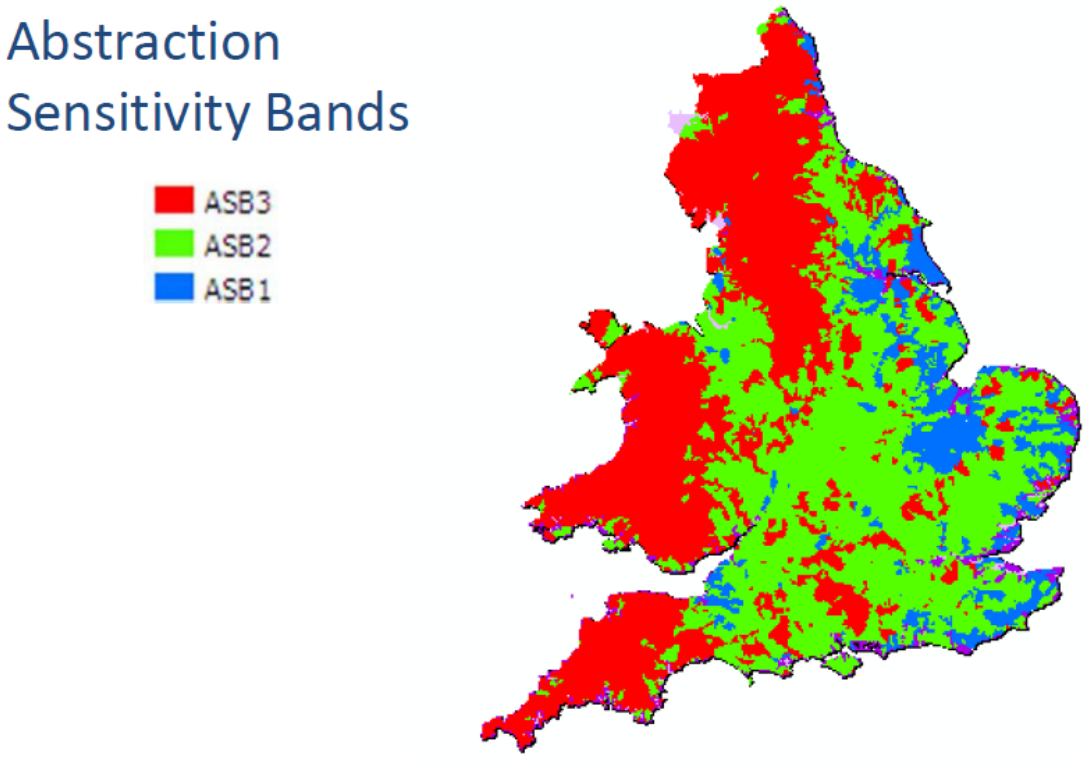
There are three abstraction sensitivity bands assigned to each water body in England and Wales: ASB1 – low sensitivity; ASB2 – moderate sensitivity and ASB3 – high sensitivity.

Each of these sensitivity bands was developed from assessment of 3 components:

- Physical typology.
- Macroinvertebrate typology
- Fish typology

Scores and confidence ratings from each component are combined to give the overall ASB for the water body.

The distribution of ASBs to water bodies across England and Wales is shown below:



Responding to this consultation

Key dates

The consultation will start on 21 January 2013 and run for 10 weeks until 2 April 2013.

How to respond

The consultation documents are available to view online at https://consult.environment-agency.gov.uk/portal/. For a printed version of the consultation documents please email your request to enquiries@environment-agency.gov.uk or contact us on 03708 506 506 (Mon-Fri, 8am - 6pm).

We would prefer you to respond online. This will enable you to manage your comments more effectively and at the same time it will help us to gather and summarise responses quickly and accurately.

However, if you would like to send your response by post, please send your completed response form to:

Eileen Falkner
Environment Agency
Horizon House
Deanery Road
Bristol BS1 5AH

How we will use your information

We will use your information to help shape to help shape the development of the revised edition of the Hydropower Good Practice Guidelines. We aim to publish this later in 2013.

Throughout the consultation we will look to make all comments (excluding personal information) publicly available on our website. This includes comments received online, by email, post and by fax, unless you have specifically requested that we keep your response confidential. We will not publish names of individuals who respond. But we will publish the name of the organisation for those responses made on behalf of organisations.

If you respond online or provide us with an email address, we will acknowledge your response. And after the consultation has closed we will publish a summary of the responses on our website. We will contact you to let you know when this is available.

In accordance with the Freedom of Information Act 2000, we may be required to publish your response to this consultation, but will not include any personal information. If you have requested your response to be kept confidential, we may still be required to provide a summary it.

Consultation principles

We are running this consultation in accordance with the guidance set out in the government's consultation principles. If you have any questions or complaints about the way this consultation has been carried out, please contact:

Emma Hammonds, Consultation Co-ordinator
Environment Agency,
Horizon House
Deanery Road
Bristol BS1 5AH

Email: emma.hammonds@environment-agency.gov.uk

Glossary

Abstraction	The removal of water from a watercourse.
Approach velocity	The speed at which the water flowing towards an intake hits the fish screen. See also ‘escape velocity’.
Base flow	The component of streamflow that originates from groundwater and supports streamflows during long periods of no rainfall.
Base flow index	The ratio of mean annual baseflow to mean annual flow.
Biota	Animals and plants.
Bywash	The arrangement of flow that is needed to prevent fish from becoming trapped by, or caught up in, the screening at a hydropower scheme.
Coarse fish	A freshwater fish that is not a member of the salmon family.
Depleted reach	This is the section of a watercourse between the point where water is taken out of the river and the point at which it is returned.
Designated site	These include Sites of Special Scientific Interest, Special Areas of Conservation, Special Protection Areas and Ramsar sites. These sites have designated features which have various degrees of legal protection.
Ecological status	The Water Framework Directive classifies all water bodies in terms of their ecological condition or status.
Ecosystem	The interactions of a community of living organisms with their environment.
Fish pass	There are many types of fish pass. For information visit http://www.environment-agency.gov.uk/business/sectors/37579.aspx
Flashy flow	Frequent, heavy flows of short duration in a river or watercourse.
Flow Duration Curve (FDC)	The statistical availability of any given flow, based on the best available information.
Hands-Off Flow	This is the minimum flow that needs to flow over the weir and down the depleted reach.
Hydromorphology	The form and function of the river channel as well as its connectivity and flow regime. This defines its ability to allow migration of aquatic organisms and maintain natural sediment transport.
Intake	The point at which water is diverted from the river towards the hydropower turbine.
Invertebrates	Animal species that do not develop a spinal column.
Kick-net sampling	A sampling method for streams and rivers involving placing a net on the riverbed and disturbing the area upstream with a kicking motion.

Leat	A man-made water channel.
Macrophytes	Aquatic plants
Main river	Usually larger streams and rivers or smaller watercourses of local significance. In England Defra decides which watercourses are the main rivers, and the Welsh Government does this in Wales.
Mitigation	The measures taken to reduce or remove the risk of activity causing damage.
Naturalised flow	River flow in the absence of abstractions and discharges.
'Pool and riffle' rivers	Rivers where shallow, rougher sections alternate with deeper, calmer ones.
Qnn	The natural river flow that is exceeded for a percentage (shown by nn) of the year. For example, Q95 is the natural river flow exceeded for 95% of the year.
Qmean	The mean flow of a river. It is usually calculated from the daily mean flows for a given period.
Reach	A continuous stretch of river.
Salmonid	A fish of the salmon family.
Screen	Fish screens can be physical barriers that block fish passage or behavioural screens that steer fish away from danger.
Special Area of Conservation	Special Areas of Conservation (SACs) are strictly protected sites designated under the EC Habitats Directive.
Turbine	Many different types of turbine are used in hydropower schemes. For more information on the different types, see http://www.british-hydro.org/mini-hydro/download.pdf (pages 23-24).
Water Framework Directive	This EU legislation requires member states to plan and act to protect and improve the water environment. It has significant implications for hydropower schemes.
Weir pool	An area of water below a weir (or similar impounding structure).

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