Guidance for applicants on supporting information requirements for hydropower applications

The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR)

marinescotland

natural scotland
SCOTTISH GOVERNMENT

SEPA
Scottish Environment Protection Agency

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

Contents

1 Purpose of this guidance

This guidance is directed at anybody planning to build a hydropower scheme in Scotland. All hydropower schemes require a water use licence from the Scottish Environment Protection Agency (SEPA) and developers should contact their nearest SEPA office to seek advice and guidance well in advance of their application.

This document is designed to help developers with their application, by explaining the process of applying for a water use licence and, in particular, on the minimum information a hydropower developer will need to provide SEPA in support of their application. The document also highlights where other consents are necessary for a development and how these may interact with the SEPA determination.

This document focuses on the run-of-river hydropower schemes, ie schemes with less than 24 hours worth of storage, and is designed to address specific impacts on the water environment. Of course, there are other issues, such as landscape and many terrestrial habitats and species, which are also important considerations in the planning process, but these are not directly associated with the water environment and are therefore not covered in this document.

This document focuses on the typical requirements for high head schemes. For low head schemes, for example Archimedes screw turbines, the information requirements may be different. If you are planning this kind of development you should contact your local SEPA office in the first instance.

1.1 Balancing the benefits of renewables and environmental protection

SEPA supports the development of renewable energy in Scotland, including hydropower. However, even small hydropower schemes have the potential to adversely affect the water environment. SEPA aims to ensure that an appropriate balance between promoting hydropower and protecting the water environment and other water users is always achieved. This balancing determination will be in line with the policy statement issued by the Scottish Government in January 2010:
www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17851-1/HydroPolicy

Ministers recognise the valuable contribution that hydropower generation makes to Scotland's renewables targets. At the same time they wish to take appropriate measures to protect Scotland's water environment from significant adverse impacts. This policy statement describes how Ministers will seek to achieve an appropriate balance between these equally important considerations.

In order to optimise the potential for hydropower generation, emphasis will be placed on supporting hydropower developments which can make a significant contribution to Scotland's renewables targets while also minimising any adverse impacts on the water environment.

Such schemes are generally those with a generation capacity of 100 kW or more, and Ministers accept that in supporting those schemes some deterioration of the water environment may be necessary. However any deterioration must be justifiable in terms of costs and benefits, and therefore considerations such as wider social or economic benefits, or impacts on other users of the water environment, will continue to be important factors in the decision-making process.

Small schemes with a generating capacity of less than 100 kW may provide local economic benefits and, where they can be shown to have no adverse impact on the water environment, such schemes will be welcomed. At this scale of development, particular attention will need to be given to managing both the individual and cumulative impacts. Generally no deterioration will be permitted, unless the proposed scheme delivers particularly significant benefits.

1.2 Regulatory background

The Water Environment and Water Services (Scotland) Act 2003 is the enabling act for the European Water Framework Directive, which introduced a new integrated approach to the protection, improvement and sustainable use of the water environment. The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) introduced controls on previously unregulated activities, including water abstractions and impoundments, which is of significant relevance to hydropower developments.

All hydropower developments will require a Controlled Activities Regulation (CAR) authorisation for abstractions, impounding works (weirs and dams) and any other engineering works associated with the scheme.

1.3 Applicant information

To determine an application, SEPA has to assess the effects of the proposal on the water environment and on the interests of those who use it. The type of information SEPA will require varies with the scale of the potential environmental risks and impacts of the proposal. Applicants must provide the information SEPA reasonably requires to carry out such risk assessments, and the best way of making sure you provide the information is to get in touch with the relevant SEPA office well in advance of submitting your application. SEPA is happy to provide advice at the initial scoping stage of any proposed development.

The potential effects of other parts of a scheme are considered under other control regimes. These typically include the construction of turbine houses and connections to power lines. These will be considered through the planning process, though where these have the potential to impact the water environment or other water users, SEPA may be involved.

Forms

Applications for abstractions, impounding works and for any engineering works directly associated with intake structures or tailrace outfalls should be made using a single application form. The application should include any temporary works undertaken during the construction phase (eg temporary channel diversions).

Separate application forms should be completed for any engineering works that are not associated with intake or outfall structures, for example, pipeline crossings or bank protection works.

The application forms and guidance on how to fill them in can be obtained on the SEPA website:
www.sepa.org.uk/water/water_regulation/car_application_forms.aspx

Application fees

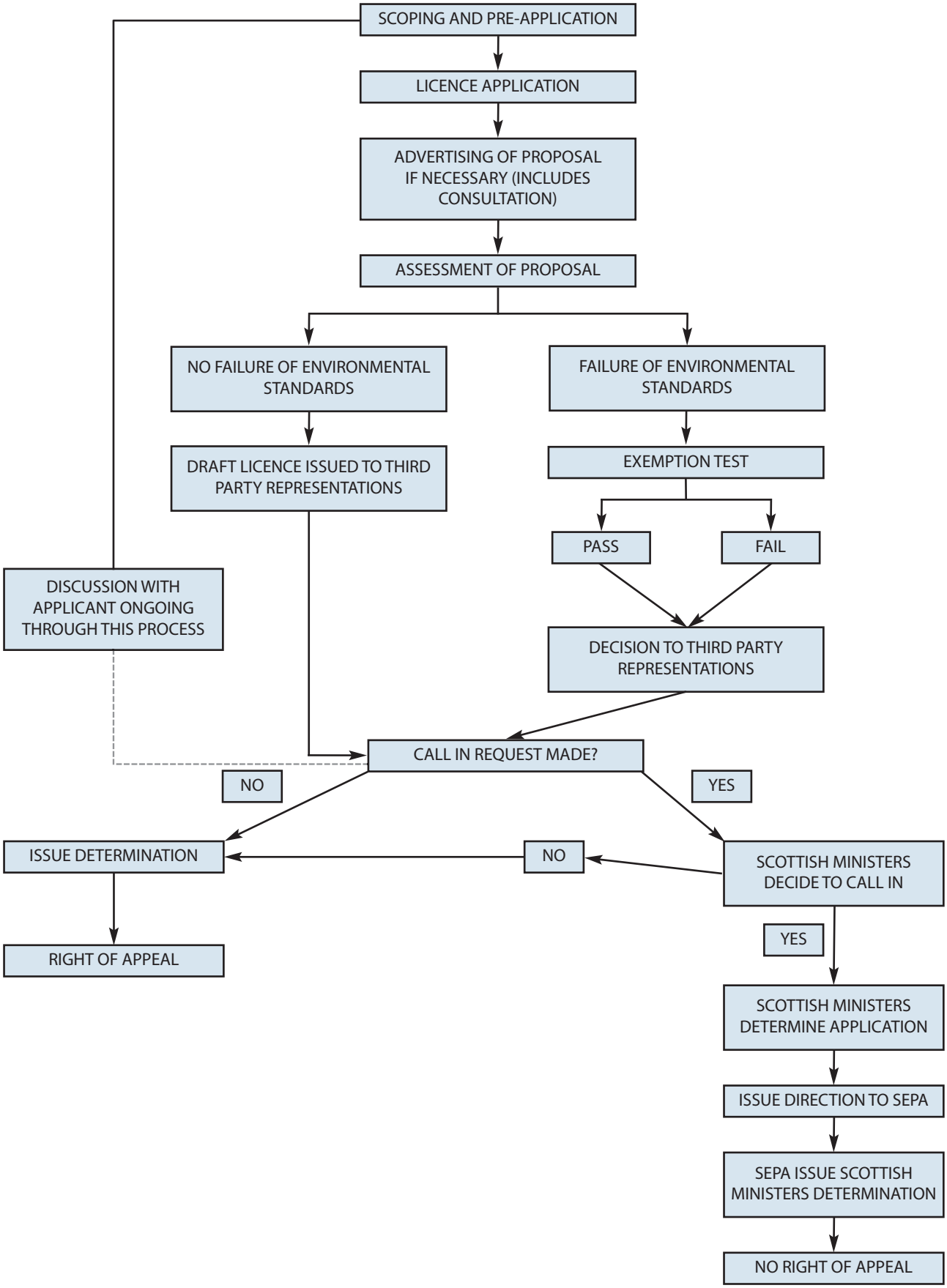
Summary information on the application fees that must accompany applications is provided in Table 1 below. Where applicable, an annual subsistence fee will be payable to SEPA once an licence has been granted. Full details of the charging scheme is available on the SEPA website:
www.sepa.org.uk/water/water_regulation/charging_scheme.aspx

Table 1: Structure of application fees and subsistence charges for hydropower schemes

Installed capacity	≤100kW	>100kW	
Application fee	A simple licence fee for all abstractions and impounding works	Normal application fees	
Installed capacity	≤2 MW	>2 - <5MW	≥5 MW
Subsistence fee	Exempt	One flat rate for all abstractions and one for all impounding works storing >25 megalitres	Normal subsistence fees

Application determination process

The flow chart below outlines the main steps involved in determining a licence application.



Timescales

SEPA is required to determine licence applications within four months. This excludes the period allowed for advertising the application and any time taken by an applicant or third parties to respond to requests for further information made by SEPA, following receipt of the application. The four-month period may be extended by written agreement with the applicant.

Due to the complex nature of hydropower developments, we recommend developers discuss their application with SEPA prior to submitting it; then we can advise them of any supplementary information they may need to provide.

Advertisement

Once the applicant has submitted their proposal, they will normally be required to advertise it via an appropriate vehicle (eg newspaper). SEPA will advise the applicant of this after reviewing the application.

Further information

For further information on SEPA's position statements, regulatory methods and guidance that apply to abstraction and impoundment regimes, visit:
www.sepa.org.uk/water/water_regulation/guidance/abstraction_and_impoundment.aspx

1.4 Other relevant consents

Hydropower developments must also obtain development consent from the local authority or Scottish Ministers, as applicable (see Table 2). The information required to support applications for these consents is not described in this guidance, however SEPA will provide advice to local authorities and Scottish Ministers on matters relating to the water environment.

Hydropower projects may also be subject to the requirements of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 or the Environmental Impact Assessment (Scotland) Regulations 1999 (See Table 2).

If your project is subject to either of the above environmental impact assessment regulations, you must submit an environmental statement describing the proposal and its likely significant environmental effects, to the relevant competent authority for the EIA. You should contact the appropriate authority for the environmental impact assessment for further information.

The requirement to prepare an environmental statement does not affect the environmental information needed by SEPA to determine a Controlled Activities Regulation application. It is worthwhile contacting SEPA and the appropriate planning authority at the scoping stage to ensure all appropriate information is provided and there is no duplication of effort. The information that SEPA requires is as described in this document and may be provided by including the information within a single environmental statement which meets the requirements of all responsible authorities.

Where the development is located within a Natura site, (such as a Special Area for Conservation or Special Protection Area), or could have an impact on a qualifying feature of a Natura site, the requirements of the European Habitats Directive will be applicable. SEPA will be required to act as a competent authority and determine whether the proposal will have a 'likely significant effect' on a qualifying interest of the site, either alone or in combination with other projects or plans. If this is seen to be the case, then SEPA will be required to undertake an appropriate assessment to ensure that there is no adverse impact on the integrity of the site. These regulations apply to all Natura sites, and may include terrestrial habitats and species and birds, as well as aquatic habitats and species. In cases where a development may affect a Natura site, developers may have to provide further detail in addition to the general supporting information described in this guidance. If insufficient detail is provided to allow SEPA to ascertain whether the integrity of a European site will not be adversely affected, the application must be refused, unless there are imperative reasons of overriding public interest. It should be noted that more than one appropriate assessment may be undertaken for a single development, one by SEPA, and another by the relevant planning authority. The same information may be relevant for both appropriate assessments. For more information on the habitats and birds directives, visit:
www.scotland.gov.uk/library3/nature/habd-00.asp

Hydropower schemes may also need to comply with the Salmon (Fish Passes and Screens) (Scotland) Regulations 1994. Regulatory guidance notes on appropriate designs of fish passes and screens that will help to ensure the regulations are complied with are available from Marine Scotland:
www.scotland.gov.uk/About/Directorates/Wealthier-and-Fairer/marine-scotland

To view the regulations, visit: www.opsi.gov.uk/si/si1994/uksi_19942524_en_1.htm

There is a 2003 amendment to the regulations, which deals with maintenance issues:
www.scotland.gov.uk/Publications/2003/03/16199

Table 2 below outlines the planning requirements for hydro schemes. Under the Water Framework Directive, SEPA has to consider the socio-economic impacts of a development in terms of the water environment and its use. The planning authority will also consider the socio economic impacts. This may appear to be a duplication of efforts; however this is not the case as each of the two authorities has a different remit.

Table 2: Summary of other development consent requirements

Size (installed capacity)	Consent	Determining authority	Environmental impact assessment?
>1MW	Section 36, Electricity Act 1989	Scottish Ministers	Yes
>500kW to ≤1MW	Town & Country Planning Act 1997	Local authority	Yes
≤500kW	Town & Country Planning Act 1997	Local authority	If in a 'sensitive area'*

*A sensitive area is a Site of Special Scientific Interest, a National Scenic Area, a National Park, a World Heritage Site, a Scheduled Monument, a Ramsar Site or a Natura Site (ie Special Areas of Conservation under the Habitats Directive or Special Protection Areas under the Wild Birds Directive).

The boxes below show each organisation/body and their requirements and remit. Some of these organisations may not be involved in the determination process but listed below for information.

Local planning authority (less than or equal to 1MW)
Scottish Government (more than 1MW)

The planning authority will consider the acceptability of proposed hydro schemes in terms of land use. It will consult relevant statutory consultees on the likely impact of such proposals and request their advice on the scope of environmental impact assessments prepared. Consideration will also be given to relevant Scottish planning policy and the authority's own local development plan and strategic development plan (where appropriate), along with any relevant supplementary planning guidance. Key considerations from a planning perspective include:

- contributing to the Scottish Government's renewable energy targets;
- landscaping;
- appropriate sighting of structures associated with the proposals;
- routing of supporting pipelines and road networks;
- potential impact on sensitive habitats, protected species and existing water users.

Scottish Natural Heritage

Scottish Natural Heritage (SNH) is a responsible authority with statutory duties to secure the conservation and enhancement of Scotland's natural heritage. It aims to foster an understanding and enjoyment of it, and encourage its sustainable use. SNH supports the development of renewable energy as part of the Scottish Government's targets to address climate change, provided there is an appropriate technology mix and that renewables are developed alongside energy efficiency targets and measures to reduce energy demand.

Furthermore, SNH seeks a strategic approach in which renewable energy development is guided towards the locations and the technologies most easily accommodated within Scotland's landscapes and habitats, without adverse impact, and which safeguard elements of the natural heritage which are nationally and internationally important.

Fisheries (Electricity) Committee

The Fisheries (Electricity) Committee is also a responsible authority with duties to advise Scottish Ministers on matters relating to the protection of fishery interests, including advice on mitigation measures while facilitating the development of hydro-electric schemes. The committee also has a statutory duty to further the conservation of biodiversity. Its interests include, inter alia, migratory fish, resident fish, preservation of migratory routes and opportunities, spawning and nursery areas (including incubation habitat) and feeding areas. It covers all freshwater fish including, among others, eels, lampreys, Arctic charr and other salmonids, as well as the entire ecosystem to support all these. The impact of hydro-electric schemes on hydrology, sediment processes, water quality, aquatic life and habitat, together with the effect on the riparian ecosystem, are all included in the assessment of the potential impact of any proposed development.

District Salmon Fishery Boards

The Salmon Fishery Boards were established to protect, preserve and develop salmon fisheries in Scotland. They represent, co-ordinate and promote the interests of Scottish salmon and sea trout fisheries, and generally take the necessary steps to protect, preserve and develop salmon fisheries in Scotland, while also having regard for the environment and other fauna and flora. There is also an Association of Salmon Fishery Boards[1] which attends to the general interests of its member boards.

Marine Scotland

Marine Scotland was established on April 1 2009 as a Directorate of the Scottish Government. It incorporates the functions and resources of the former Scottish Government Marine Directorate in Edinburgh and the former Fisheries Research Services Freshwater and Marine Laboratories at Pitlochry and Aberdeen.

Rivers and Fisheries Trusts of Scotland

Rivers and Fisheries Trusts of Scotland[2] is an independent freshwater conservation charity representing Scotland's national network of rivers and fisheries trusts and foundations. The core objective is the conservation and enhancement of native freshwater fish and their environments in Scotland.

[1] www.asfb.org.uk/members/members.asp
[2] www.rafts.org.uk/members/members.asp

2 Environmental standards

Environmental standards define the conditions necessary to protect aquatic plant and animal communities. For example, environmental standards for river flows define the degree of reduction in river flows (eg due to water abstraction) that an aquatic ecosystem can tolerate without significant adverse changes to its plant or animal communities.

Environmental standards are used by SEPA to assess risks to the ecological quality of the water environment posed by proposed abstractions, discharges and engineering works. SEPA does this by modelling whether a proposed controlled activity will cause an environmental standard to be failed. SEPA also compares its monitoring and modelling results with environmental standards in order to classify the ecological status of the water environment.

The environmental standards which SEPA is directed by Scottish Ministers to apply for the above purposes are set out in the 2009 directions: www.scotland.gov.uk/Publications/2009/12/14130729/0

The Scottish Government's policy statement 'Implementing the Water Environment & Water Services (Scotland) Act 2003: Developments of environmental standards & conditions' provides further information on how SEPA and other regulators use environmental standards to protect and, where necessary, improve the water environment: www.scotland.gov.uk/Publications/2007/03/29111642/0

Nearly all hydropower schemes result in a failure of the environmental standards which are in place to prevent significant adverse impacts on the ecological quality of the water environment. Proposed activities that fail the environmental standards do not necessarily mean an application will be refused if it is seen to provide certain socio-economic benefits. This failure requires SEPA to undertake an assessment of the potential benefits of the development against the potential negative environmental impact with any positive environmental, socio-economic benefits. Mitigation will also need to be tailored to each scheme as this will also be factored into the balancing test. Third party interests and other water users will have significant input into the determination via the statutory advertising process. SEPA will use its regulatory method 'WAT-RM-34: assessing applications likely to result in significant adverse impacts on the water environment', to determine these applications. This can be found at: www.sepa.org.uk/water/water_regulation/guidance/all_regimes.aspx

3 Supporting information requirements

This section outlines the information SEPA will require from applicants. Further technical guidance on how this information should be collected is provided in the Annexes at the end of the document.

The information we require depends on the environmental risk posed by the proposal and, hence, the potential implications of the determination.

The requirements set out in this document are indicative, so additional information may be required in some cases. It only covers aspects relating to the water environment and does not lay out the information requirements needed by planning authorities. You should contact your local planning authority to find out what information they will want you to provide.

Where the information provided to SEPA is incomplete or of poor quality, significant delays in determining applications may result. In some cases, we may refuse to consider an application where inadequate information is provided. Delays may be incurred if an applicant is asked to provide information that is integral to the determination, as the clock can be stopped on the statutory determination time until the required information is provided. It is therefore in everybody's interest to ensure that the correct information is submitted with the application.

We recommend that developers contact SEPA at an early stage to discuss information requirements. Where necessary, we may seek to convene a meeting of relevant responsible authorities, other public bodies and the developer to discuss specific information requirements. SEPA will also be happy to attend meetings of this type organised by developers.

Where information is provided to support an application, the qualifications and experience of those involved in site surveys or providing other technical information should be described. The following list summarises the minimal information required to accept an application as valid:

Outline description of scheme design, stating which rivers and lochs (watercourses) are affected or could be affected by the development and including a map of the scheme showing the location of each controlled activity being proposed.

- Outline description of scheme design, stating which watercourses (rivers and lochs) will or could be affected by the development, including a map of the scheme showing the location of each controlled activity being proposed.
- An 8-figure National Grid Reference for the location of each proposed controlled activity and photographs showing the character of the watercourse at those locations (with a reference scale in the photograph).
- Maximum installed capacity (kilowatts) of the scheme and an estimate of the mean annual power expected to be generated (gigawatt hours).
- Minimum and maximum abstracted flow for each intake, including minimum river flow at which generation will commence.
- The hands off flow proposed and the residual flow at maximum abstraction. If possible, supply photographs of the watercourse at the proposed hands off flow.
- Details of the design of each impounding works, including the height as measured from the downstream toe of the works to the crest or top of the spillway; and, where practicable, an estimate of the length, surface area and volume of the impoundment (ie the pool) expected to be created upstream of each intake structure.
- Information on designated sites that may be affected by the development.
- Details of the river flow that will pass over, through or around the intake structure into the downstream river, including how the flow will vary and how the design of the intake structure enables downstream flow to be provided.
- Information on whether the watercourses involved are important to fish and fisheries at a local, catchment or national level, and the locations (with 8-figure National Grid References) of the upstream limit(s) of salmon, sea trout, eels, lamprey, spawning river trout or loch trout in the watercourses involved, or, as appropriate, downstream of them. Information may be required on other fish species if known to be present, for instance, Arctic charr.

- Details of fish screening measures planned for each intake structure.
- Details of any provisions made to allow fish to pass safely downstream and upstream if appropriate at the intake structure.
- Details of how tailrace flows will be returned to the water environment, including the location of the outfall, the engineering works involved in the construction of the outfall and any fish screening measures. Photographs of the proposed outfall site should also be supplied. The date and time of each photograph must be indicated to allow SEPA to link in with gauging records.
- Information on other activities in the same catchment, which could have a potential cumulative effect.
- Photographs of the river taken from the same point near the proposed impounding works at low flows after at least two days of dry weather; at medium flows and at high flows (designed to represent a variety of weather conditions). The date and time of each photograph must be indicated to allow SEPA to link in with gauging records.
- Photographs of the affected reach showing the representative characteristics of the river bed and bank (See section 3b and 3d) at low, medium and high flows. This should include a minimum of three photographs within a 500m stretch upstream of the intake.
- Photographs of potential obstacles (with a scale for perspective) to fish movement taken at a range of flows. The date and time of each photograph must be indicated to allow SEPA to link in with gauging records.
- See Table 4 for further information on photograph requirements.

In addition to the general information outlined in Table 3, SEPA will also require the information as described in the following sections:

- Hydrological information
- Information on fish and fish habitat
- Information on fish for schemes in protected areas
- Information on other protected species
- Bryophytes and hydro schemes
- Information on morphological characteristics
- Built heritage
- Landscape
- Recreational use.

3.1 Hydrological information

The information required by SEPA on river flows is summarised in Table 3. Where one of a number of the different flow information requirements may apply, please contact us to determine which is applicable.

The information applicants' supply on flows must be sufficient to give us confidence in the accuracy of our calculated flow duration curve for the river. We therefore recommend that applicants contact us at an early stage in the scheme design, so that:

- the river flow information collected will be sufficient for our purposes;
- the applicant's assessment of the flow duration curve for the river is consistent with ours;
- any relevant flow data we hold can be made available to the applicant to help them assess the resource available.

Table 3: River flow information requirements

Distance measured along the middle of the river channel between the intake structure and the outfall (metres)	Installed capacity (kW)			
	<15	15 to <100	100 to <500	>500
<100	A	B	B - C	C - D
100 to <500	A	B - C	C - D	D
500 to <1500	B	B - D	C - E	D - E
≥1500	B	B - D	D - E	D - E

Key to different flow information requirements:

A. Supporting photographs of indicative flows and measurements of channel width and depth in metres.

B. Single or multiple measurement of flow – simplified method of measurement (see Annex A).

C. Single or multiple measurements of flow – use of flow measurement devices (see SEPA guidance 'WAT-SG-54 Water resource for technical guidance on flow measurement': www.sepa.org.uk/water/water_regulation/guidance/abstraction_and_impoundment.aspx

D. Short periods of logged level data calibrated to flow.

E. One year or more of logged data calibrated to flow.

1. Where there is more than one intake, the distance between the intakes and the turbine tailrace will include the relevant lengths of each tributary. SEPA will accept distances measured using 1:25,000 Ordnance Survey maps, referring to grid references for intakes and tailrace.
2. Within the ranges of flows and impacted reaches the level of detail required should be proportionate to the scale of the scheme and the environmental risk.

Please note: Where requirements fall into more than one category, please contact SEPA to find out which is required. The type of measurement will depend on the site location.

We will not need the information on river flows specified in Table 3 where the applicant has an appropriately located gauging station that provides river flow measurements. Where an applicant has undertaken flow modelling, we will need this to be submitted in support of the application.

Part 1 of Annex A provides additional background details and guidance on the different flow information requirements. Part 3 of Annex A shows how the hydrological information supplied by the developer is used in defining the mechanisms for protecting the water environment between the intake and the tailrace of the turbine house. This mitigation has to take into consideration both the needs of the aquatic ecology and the water use by third parties.

3.2 Information on fish and fish habitat

SEPA will require information on how important the watercourses involved are to fish and fisheries at a local, regional, catchment, national or international level, and details including the locations of the present upstream limit(s) of salmon, sea trout, eels, lamprey, spawning river trout or loch trout (this list may include other species at certain sites) in the watercourses or, as appropriate, downstream of them. Your local District Salmon Fishery Board or Fisheries Trust may be a helpful start.

We will require an assessment of the suitability for fish in the river habitat between the upstream end of the impounded river flow and the scheme outfall and further upstream if it is possible that spawning fish can ascend all the way up the stretch between the outfall and the intake to access habitat upstream. The level of detail required will depend on the relative risk of the scheme, as outlined in the fish survey information requirements in Table 4.

SEPA will require applicants to identify likely natural and artificial obstacles to fish migration upstream and downstream of the intake structure. This is because watercourses which are accessible to migratory fish often contain a more diverse and abundant fish community than areas not accessible to migratory fish above high waterfalls, and additional mitigation may be required in these cases. Annex B describes the information required on obstacles to migration. Where there is uncertainty over the significance of a waterfall, we may require the applicant to provide fish survey data to assess in more detail whether it is an impassable obstacle for all species. It is very important that the exact location of any waterfall which is suggested to be impassable is given, and that the justification for considering it to be impassable is given.

In certain cases, we will also require information on fish populations. The information required and the circumstances in which it is needed are summarised in Table 4. Part 3 of Annex B explains how to collect, as applicable, quantitative or semi-quantitative information on fish populations.

Table 4: Fish survey information requirements

Distance measured along the middle of the river channel between the upstream limit of impounded river flow and the outfall (metres)	River width (metres)			
	<1	1 to <2	2 to 5	>5
20 to <100	N, HP	N, HP	N1, HP	S, HP
100 to <250	N, HP	S, HP	S, HP	S, HP
250 to <500	N, HP	S, HP	Q, HP	Q, HF
≥500	S, HP	Q, HF	Q, HF	Q, HF

1 See note below concerning Special Areas of Conservation:

No survey is required if:

- the distance measured along the middle of the river channel between the upstream limit of impounded river flow and the outfall is less than 20 metres;
- the river bed is entirely, or almost entirely, smooth bedrock of a character which provides no cover for fish;
- the river bed is entirely artificial (eg a concrete bed);
- the entire scheme is to be located above an obvious natural obstacle* to migration of salmon, sea trout, lampreys and eels or river or loch trout and the habitat does not contain fish populations which are known to be rare or distinct (clarification from SEPA and SNH should be sought on this last point if necessary – such a river will generally contain a population of resident brown trout);
- SEPA already holds the relevant information – please check with SEPA before undertaking any survey work.

*In all cases where likely obstacles to fish migration are identified, photographs of the obstacles should be provided, including a reference object to allow the scale of the obstacle to be judged. Photographs should be taken at a range of water flows to allow the obstacle to be assessed accurately.

If it is possible that spawning fish can ascend all the way up the stretch between the outfall and the intake to access habitat upstream, survey work upstream may also be required and this should be discussed with SEPA.

N: No fish habitat survey and no electrofishing survey required.

S: Semi-quantitative electrofishing survey.

Q: Quantitative electrofishing survey.

HP: Qualitative habitat survey comprising photographs of the affected stretch showing characteristics of the bed and banks and significant obstacles to migrating fish species. The photographs should be taken at times of low flow and sufficient water clarity so that the composition of the bed can be clearly seen. Measurements of the width and depth of the river channel, and the location at which they were measured, should be attached to each photograph.

HF: Full fish habitat survey as described in Part 1 of Annex B.

If a river falls into a category where no survey is required, assumptions will be made by SEPA about what fish it is most likely to contain.

Where the river is within, or connected to, a Special Area of Conservation (SAC) for Atlantic salmon or freshwater pearl mussel, a qualitative habitat survey will be required in support of applications that otherwise would require no fish habitat survey or electrofishing survey. A semi-quantitative electrofishing survey will also be required if the river is 2 to 5 metres wide and the affected length less than 100 metres. Further survey information may also be required in SACs in particular circumstances, and in such circumstances applicants are strongly encouraged to have early discussions with SEPA and SNH.

3.3 Information on fish for schemes that are located in or connected to designated sites

If the scheme has the potential to impact on an area designated as a Special Area of Conservation (SAC) or other designated sites (eg Sites of Special Scientific Interest) for one or more fish species, additional information may be required. This will depend on the fish species concerned. The information requirements for Special Areas of Conservation are summarised in Table 5. SNH provides data and information on designated sites all over Scotland: www.snh.org.uk/snhi/

You can view the extent of designated site boundaries, find out about the important features of sites and download supporting documents. A scheme may be proposed in a river out-with the SAC designated boundaries, but with the potential to affect the SAC. In such cases, where connectivity can be established, there is the potential to have an impact on populations within the SAC. If the proposal is considered to have a likely significant effect on a qualifying interest of any Natura site, either alone or in combination with other projects or plans, an appropriate assessment will be carried out by SEPA using information supplied from the applicant and other sources. SNH will provide advice to SEPA in such circumstances.

The requirements in Table 5 for lampreys only apply if the scheme is located within the geographic range of the species within the designated site boundary. Please check with SNH before undertaking any survey work. Any correspondence with SNH should be submitted with the application. Guidance on lamprey sampling in SACs can be found in Annex C of this guidance and at: www.english-nature.org.uk/LIFEinUKRivers/species/lamprey.html

Table 5: Additional information on fish for schemes located in or connected to rivers designated as Special Areas of Conservation for fish species

Information	Fish species for which the site has been designated		
	Atlantic salmon	River lamprey and brook lamprey	Sea lamprey
On fish habitat	Standard information as described in Section 3.5	Information on the location and extent of potential river lamprey and brook lamprey habitat within the affected stretch	Information on the location and extent of potential sea lamprey habitat within the affected stretch
On fish populations	Standard information as described in Section 3.5	If potential habitat for lamprey larvae is present, an appropriate semi-quantitative electro-fishing survey	If potential habitat for lamprey larvae is present, appropriate semi-quantitative electro-fishing survey

Part 1 of Annex C explains how potential lamprey habitat should be identified. Part 2 of Annex C provides guidance on how to undertake a semi-quantitative electro-fishing survey for lampreys, if applicable.

3.4 Information requirements for sites designated for features other than fish

If the scheme has the potential to impact on an area designated as a Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI), Special Protection Area, etc, additional information to that stated in this section and Section 3.5 may be required. This will depend on the features for which the site is designated (see the SNH website: www.snh.org.uk/snhi).

Where the qualifying or notified features of a designated site are water dependent, SEPA expects appropriate supporting information to form part of the developer's application. There are a wide range of species and habitats in designated sites in Scotland that may be affected by hydro development. As well as water dependent species, these include terrestrial habitats and species too. While it is beyond the scope of this document to cover them all, here are some information requirements for some features that are particularly vulnerable to hydro power development:

Freshwater pearl mussels

If the proposal is in a catchment designated as a Special Area of Conservation or Site of Special Scientific Interest for freshwater pearl mussels, the applicant should seek SNH's advice as to whether the proposed controlled activities are located within the limits of the geographic range of freshwater pearl mussels within the site. Freshwater pearl mussels are also present in locations outside designated sites and SNH can advise on any known locations of pearl mussels. They are protected under Schedule 5 of the Wildlife & Countryside Act 1981 (as amended). This makes it an offence to intentionally or recklessly kill, injure, take or disturb this species or to damage their habitat. If the proposed activities are to be located within the geographic range of freshwater pearl mussels (which extends across most of Scotland, aside from the Borders and parts of the Lothians and Fife), and in a river that is not either ephemeral or entirely bedrock, SEPA will require an assessment to be made as to whether freshwater pearl mussels are present. If their presence cannot be discounted, a freshwater pearl mussel survey should be undertaken of those reaches that will be affected by construction of the hydro scheme and/or subject to reduced flows. Part 3 of Annex C explains how to undertake a freshwater pearl mussel survey.

Otters

SEPA will require information on the location of any otter holts and resting places within the immediate vicinity of the engineering works associated with applications, including impounding works, unless:

- the river in which the works are to be undertaken is a ditch; or
- SNH already has survey information on otter holts in the river concerned. In some cases these data may not be recent and an additional follow-up survey may be required to identify the location of otter holts and resting places. Please contact SNH for advice.

Otters are listed on Annex IV of the Habitats Directive and Schedule 2 of the Habitats Regulations. This means that they are one of a number of European protected species which are afforded strict legal protection wherever they reside. Other examples of European protected species that reside in Scotland and may be impacted by hydroelectric developments include bats (all species), wild cats, the Natterjack toad, Great crested newt, Killarney Fern, Slender naiad and yellow marsh saxifrage. It is illegal to damage or destroy a breeding site or resting place of such an animal without a licence. Depending on why it is required, both SNH and the Scottish Government are the licensing authorities for activities that may affect listed species listed. Part 4 of Annex C explains how to undertake an otter survey.

Water vole

Water voles are protected under Schedule 5 of the Wildlife & Countryside Act 1981 (as amended). This makes it an offence to intentionally or recklessly kill, injure, take or disturb this species or to damage their habitat. SEPA will require the developer to provide information on water vole distribution within the vicinity of engineering works and watercourses likely to be affected by the development. Part 5 of Annex C explains how to undertake a survey for water voles.

3.5 Bryophytes and hydro schemes

The western part of the British Isles has international importance for its oceanic bryophyte and lichen floras, with large populations of some species that are uncommon in Europe generally and a few species that are rare or absent in the rest of Europe. Incised river valleys, and particularly rocky ravines that may be suitable for hydropower represent key refugia for these species. Oceanic bryophytes and lichens require high humidity, and a reduction in river flow may result in a negative impact on these species. Many bryophytes of oceanic ravines also depend on new habitat created when rivers are in spate and on frequent periods of inundation. The impact of an application on river corridor humidity and spate flow rates will have to be considered where a site is known or found to be important for its oceanic bryophyte and/or lichen flora.

A bryophyte and lichen survey is recommended for any Scottish hydropower application. Information on the bryophyte and lichen flora will be required if conditions 1, 2 and/or 3 below are met:

1) The application relates to a site in western Scotland (West Coast Scotland Important Plant Area or Western Isles)*.
2) The watercourse is incised and/or a wooded ravine.
3) The application relates to a site that has been designated for its bryophyte and/or lichen interest eg SSSIs or SACs.

*Important oceanic or riparian bryophyte and lichen communities may be found beyond the oceanic zone defined here, which is why a general bryophyte or lichen survey is always recommended. The West Coast Scotland IPA boundary is available from the Plantlife website: www.plantlife.org.uk/uk/assets/UKIPALAUNCH/summaries/Westcoast.pdf

In addition, if a river catchment is known to support populations of river jelly lichen (*Collema dichotomum*) and the river bed includes shelves of basic rock, a survey for this protected species is recommended. The survey results should be used to assess what the impacts of abstraction will be on the species (eg if it would increase exposure and could result in individuals becoming exposed and dying). This species is listed in Schedule 8 of the Wildlife and Countryside Act 1981 (as amended), which protects it from intentional or reckless destruction.

Species data can be obtained from existing datasets for some sites. All British bryophyte records, held by the British Bryological Society, and lichen records, held by the British Lichen Society, are publically available via the National Biodiversity Network Gateway: www.searchnbn.net

Although these public datasets are unlikely to provide information specific to the application, they may be able to indicate whether a further survey is required. Where there are insufficient records to make a judgement, the applicant should consult a competent bryologist and/or lichenologist who has expertise in oceanic species and can advise whether a further survey is required. Where a survey is required a report should include:

1) A list of oceanic bryophyte species (sensu Hill & Preston, 1998) and/or oceanic woodland lichen species (Coppins & Coppins, 2002) located between the intake and outflow points. Uncommon or vulnerable species should be highlighted.
2) Differentiation between species found within the splash zone and those only found beyond the splash zone.
3) Local context including a description of the extent and quality of similar habitat within the wider river catchment.
4) Extent and type of woodland within ravine sections of the river and likely contribution of surrounding woodland to local humidity.
5) Representative photographs of incised or wooded ravine sections that will be affected by abstraction.
6) Where the river jelly lichen is found, information should be provided on the impact of abstraction on the inundation period of the population/s.

Where an expert bryologist or lichenologist advises that a survey is not required, a brief report should be submitted that clearly justifies this advice. Photographs should be provided to clarify the case where appropriate.

*Important oceanic or riparian bryophyte and lichen communities may be found beyond the oceanic zone defined here, which is why a general bryophyte or lichen survey is always recommended. The West Coast Scotland IPA boundary is available from the Plantlife website: www.plantlife.org.uk/uk/assets/UKIPALAUNCH/summaries/Westcoast.pdf

3.6 Morphological information requirements

SEPA will require information on the river morphological type to assess potential impacts on sediment movement and transport as a result of the development. This can be assessed using photographs submitted as part of the general requirements in Table 2. Sediment management conditions will be part of any licence, and these conditions will be dependant on your site and the size of your impoundment. There may be a requirement during the determination of an application for a developer to carry out further survey work if certain sites are seen to be high risk. This may also lead to the development of a sediment management plan.

3.7 Built heritage information requirements

SEPA will require applicants to identify any Scheduled Ancient Monuments, Listed buildings or other sites or monuments on the Sites and Monuments Record or the National Monuments Record which may be directly or indirectly affected by any of the controlled activities involved in constructing or operating the proposed scheme.

Historic Scotland, the Royal Commission on the Ancient & Historical Monuments of Scotland and local authorities hold information on built heritage sites and archaeological sites.

3.8 Landscape information requirements

If the hydropower scheme could potentially result in significant adverse landscape and visual impacts, applicants are likely to be required to carry out a landscape and visual impact assessment. The assessment should be carried out in accordance with the *Guidelines for landscape and visual impact assessment 2nd Edition,* 2002 (IEMA/LI). This may form part of an environmental impact assessment. Circular 15/1999 for the Environmental Impact Assessment (Scotland) Regulations 1999 indicates that an environmental impact assessment is more likely to be required for any new hydro-electric scheme which has more than 5MW generating capacity: www.scotland.gov.uk/Publications/1999/08/circular-15-1999/circular-15-1999

3.9 Information on recreational use

Applicants will be expected to identify what they know of any recreational use of the part of water environment directly or indirectly affected by the proposed scheme. This should include evidence based on the presence of paths leading to, and along, the river or loch; the presence of moorings or fishing huts; records of observed use; or contact or communication between the applicant and recreational interest groups, including anglers, canoeists and others. The advertising and consultation process may also highlight other water users that the applicant may not have knowledge of. This may result in requests for further information.

Annex A Hydrological information

1 River flow information

Both the scheme developer and SEPA will need information on river flow characteristics and on the distance and height difference between the intake and the turbine tailrace. The developer will need this information to determine the size and type of turbine, the minimum and maximum turbine flows, and the amount of electricity generated. SEPA will need this information to compare the proposed abstraction regime to the natural flow characteristics of the river and in turn to assess the impact of the proposal on the water environment.

SEPA has been directed by the Scottish Government to assess the impact on a river's flow regime by looking at how a proposed hydro scheme alters the flow duration curve (FDC). A FDC is a convenient way of summarising the flow characteristics of a river. It provides information on the probability that a river flow is equalled or exceeded and is derived by portioning the flow hydrograph (generally as mean daily flows), ranking the flows in descending order and sorting by the probability of a given flow being exceeded. The convention is to refer to the flow corresponding to an exceedence probability x as Q(x). This is usually expressed as the percentage of time that the flow in a river is greater than the stated probability. For example, Q95 is the flow exceeded 95% of the time and is typical of a dry summer flow that occurs, on average, up to 18 days a year.

Flow duration curves are best derived using long-term local data. However as the latter is not available for most river reaches, estimates are made by hydrologists using statistical models or by linking short periods of local data to longer data sets. SEPA recognises that all of the methods used to create FDC's come with statistical uncertainty and that steps to improve this, generally require more measured flow data (see Table 3 on p12). The extra effort to collect this has to be balanced against the scale of the development, the cost of acquiring the data and the risk to the environment.

For further information on how to derive a flow duration curve using local data, please refer to the publication *How much water can a river give? Uncertainty and the flow duration curve*:
www.sepa.org.uk/science_and_research/data_and_reports/idoc.ashx?docid=2e619b9c-8ab0-461d-8fec-d3c8c9a6fb38&version=-1

2 SEPA flow calculations

SEPA's starting point for estimating a flow duration curve is to refer to SEPA's own gauging station network:
www.sepa.org.uk/water/river_levels.aspx

Where no flow data exists, SEPA will generate a flow duration curve using the LowFlow software system. User licence restrictions mean that SEPA is unable to provide LowFlow derived estimates to a developer. However, Wallingford Hydrosolutions provides a flow retrieval service using the same software:
www.hydrosolutions.co.uk/lowflows.html

In the absence of any additional supporting data, SEPA will use the confidence limits embedded within Lowflows to adopt a precautionary approach for estimating impacts of a development on the flow duration curve and for setting any flow conditions used in support of any mitigation should a licence be granted. This is likely to mean that there will be less water available to use for generation. In such cases there is a real benefit for the developer if better flow data is obtained to support their application.

Should a developer choose a different model to estimate a flow duration curve then details of it must be submitted in the supporting information including any calibration. The applicant must be aware that SEPA reserves the right to reject alternative models when it believes believe that Lowflows will be statistically more robust.

The hydrological character of a watercourse is influenced by both natural and artificial features upstream. It is important that developers take these into account when deriving flow duration curves. Examples of natural features that should be taken into account are lochs and catchment topography; examples of artificial features include abstractions, drainage and land-use such as commercial forestry. SEPA will be happy to help developers identify these features.

In order to verify that Lowflows will provide a suitable flow estimate for the site, SEPA will always require some locally obtained flow information; this is set out in Table 3 (p12). The amount of information required within the ranges of flows and impacted reaches indicated has been chosen to be proportionate to the scale of the scheme and the environmental risk. Details of the data requirements are set out below:

A Supporting photographs of the watercourse over a range of conditions particularly at a low flow on a dry day following a spell of two or more days of dry weather. The date and time of the photograph must be recorded along with and accurate grid reference. Finally include measurements of the width and depth of the channel at both the site of the proposed intake and outfall.

B For smaller schemes (those less than 100kW) where single or multiple measurements of flow are required, simplified measurement methods can be used using non-specialist equipment. In addition to the information given in 'A' above, calculate the stream flow on one or a number of site visits at a point in the river between the intake and the tailrace; generally it is a case of the more measurements over a greater range of flows the better. Data collected on a single site visit may be acceptable; this should be taken on a dry day with low flows following a spell of two or more days of dry weather. Three flow measurements, spaced at least two hours apart, should be made and these can be as simple as using a float and a stopwatch or for small watercourses a bucket and stopwatch. See SEPA guidance WAT-SG-54: www.sepa.org.uk/water/regulations/guidance/abstraction_and_impoundment.aspx

C For larger schemes (those greater than 100kW) where single or multiple measurements of flow are required, the procedure adopted is the same as in 'B' above but will require the use of specialist flow measurement devices (see SEPA guidance WAT-SG-54).

D Where short periods of continuous data are specified, a data logger is used to record water level at 15 minute intervals. This is converted to flows through a rating curve derived for the site from a number river flow measurements across the range of levels recorded. SEPA's hydrologists recommend that a minimum of six gaugings should be used for a rating curve. When 'continuous' data is available it is not critical to target gauging during a spell of dry weather; the gaugings should cover low flows and flows as high as it is safe to obtain. SEPA will require developers to submit details of the gaugings completed and how these were used to derive the rating curve. Providing the time period covers the range of flows between Q90 and Q20, results can be obtained with two to three months worth of data, though six months or more is recommended. This work is normally undertaken by a specialist in hydrology.

E Where one year or more of logged data calibrated to flow is available, the method follows 'D' above, the only difference being the period over which data is gathered.

Except for classes A and B (see Table 3), SEPA will expect developers to calculate a flow duration curve using local data, following one of the methods outlined below and as set-out in detail in the aforementioned publication *How much water can a river give? Uncertainty and the flow duration curve*. This should then be used by the developer for their own design purposes, eg for determining yields; generated output and proposed mitigation flows. All of the approaches link local data to the flow duration curve at a neighbouring gauging station (known as the analogue gauging station) with a long-term data flow set. Analogue flow data can be supplied free of charge by SEPA. The key methods are summarised below:

F Spot gauging
Individual gaugings are linked by the flow at the analogue station to the long-term flow duration exceedence for that day. Other exceedences are obtained by pro-rata adjustment (suitable for supporting data method A-C).

G Multiple spot gaugings
Each spot gauging is linked to the analogue exceedence and the results plotted on a graph. A regression is plotted to give the flow duration curve (suitable for supporting data method A-C).

H Matching pairs
Assign the mean daily flow percentiles from the analogue catchment to the mean daily flows for the site of interest. Each daily record in effect becomes equivalent to a 'spot gauging' assessment. As in 'b' above, a regression is plotted to give the flow duration curve (suitable for supporting data method D-E).

- Rescaling
  The short record flow duration curve for the site of interest is rescaled to the long-term FDC by adjusting each percentile by the ratio obtained from the analogue catchment and comparing its corresponding short-term FDC record with the long-term FDC. This requires a minimum of one year of data (suitable for supporting data method E).

SEPA will review the data collected and the FDC generated. They will also compare this FDC to that derived using the LowFlows software. Where there are discrepancies that cannot be accounted for, SEPA will discuss with the developer which approach is more robust and whether more data needs to be collected.

SEPA will be happy to provide advice at the pre-application stage. This may include advising on the amount of supporting information required, together with technical advice about how to collect and analyse the data in order to provide a flow duration curve using the methods described above.

It is not appropriate for SEPA to recommend any particular hydrological consultant. However, directories are given in the websites of the British Hydropower Association, the British Hydrological Society and Scottish Renewables.

Annex B Information on fish and fish habitat

1 How to assess habitat suitability for juvenile fish

Table 4 (p13) should be consulted to determine whether a full habitat survey is required. If it is, the survey should be designed to provide detailed information on the location, extent and condition of habitat features along and surrounding the river of interest. This should cover the part of the river which will be subjected to altered river flows and the area above any proposed new impounding works.

Information should be collected by walking the selected survey stretch and collecting general information on the current status of the instream habitats. This information should be provided in the form of a map of the river, which should be drawn to scale.

The wetted width of the river should be recorded at regular intervals along the survey stretch and widths should be indicated on the map.

Table B1: Habitat type classification

Habitat type	Classification
Bedrock channels	Areas where the streambed is predominantly bedrock, ie a continuous rock surface (see photograph 1).
Lamprey habitat	Stable/fairly stable fine sediment, particularly along the edges of watercourses. May be patchy and interspersed among coarser substrates (see photographs 2 and 5).
Productive habitat	All other areas, ie riffles, pools and glides with mixed bed substrates (see photographs 3, 4 and 5).
Obstructions to migration	Potentially impassable waterfalls, weirs, bridge sills, etc. See Part 2 of this annex for more information on identifying obstacles to migration.

Note to Table B1: The survey should be carried out under typical summer flows, to ensure that the bed is fully visible. Supporting photographs should be provided of each habitat stretch. The locations of these should be indicated on the map. It is often difficult to determine whether an obstacle is passable, so photographs should be provided showing any potential obstacles during low, medium and high flows. A vertical scale (such as a person or a metre stick) should be present in all obstacle photos to provide a clear scale.

Photo 1: Bedrock channel. The stream bed is dominated by a continuous bedrock sheet, providing poor habitat for fish.

Photograph 2: An example of juvenile lamprey habitat. Juvenile lamprey can sometimes be found in sand/silt aggregations behind large stones or boulders in midstream areas.

Photographs 3, 4 & 5: Productive habitat for salmonids. The streambed substrate includes a mixture of sizes, and is not dominated by a continuous bedrock sheet or by fine sand or silt.

Habitat units should be drawn directly onto detailed high resolution maps (usually 1:10,000 scale). Boundaries of different habitat features and types should be assessed, drawn on the map to represent their actual position on the river, and labelled. Photographs of individual stretches or specific features should be taken and their position noted on the map.

After completion, survey maps should be used to calculate the area of each habitat type which is found within the different areas of the proposal. This may be done using a geographic information system or by manually measuring from the map.

2 Identifying obstacles to fish migration

It is extremely important to know whether the area affected by each scheme is accessible to migratory fish, because this will determine which species are likely to be present, and hence what type and level of mitigation will be most appropriate. Several migratory species, such as Atlantic salmon, European eels and sea lampreys are also of particular conservation or economic importance.

Different fish species have very different swimming abilities, and it is important to consider the range of species present when considering obstacles to migration. Atlantic salmon, for example, are known for their ability to make vertical leaps. There are, however, several examples of waterfalls which cannot be negotiated by salmon, but which trout are able to ascend, due to their greater willingness to use shallower side channels. Lamprey species are particularly affected by high gradient channels. River lampreys, for example, are often unable to pass any obstacle with a sustained gradient of more than 1:5. However, adult lampreys can use their suckers to attach to smooth surfaces and rest between bursts of swimming however, which can allow them to negotiate larger obstacles than might be expected. Juvenile eels (elvers) migrate upstream, with adults migrating downstream to the sea. Elvers cannot leap, but can climb up obstacles under certain conditions where vegetation or rough surfaces are available.

The individual swimming and jumping abilities of various fish species has been studied, particularly for salmonid species, and is given in Table B2. Vertical barriers which are higher than this could reasonably be considered to be limits to migration for these species. It is therefore critical to provide detailed photographs of any obstacles, and these must include a reference object such as a metre stick, which can be used to accurately judge the height of each obstacle.

Table B2: The leaping ability of key species, with note on their behaviour at obstacles.

Species	Ability to leap	Notes
Adult salmon	Yes (<3.7m)	
Adult trout	Yes (<1.81m)	
Adult lamprey	No	Can attach to smooth surfaces.
Juvenile eel	No	Have the ability to climb vegetation and rough surfaces.
Grayling	Yes (<0.96m)	

Note: This information is summarised from Environment Agency data: www.sniffer.org.uk/Webcontrol/Secure/ClientSpecific/ResourceManagement/UploadedFiles/SEPA_WFD111_Phase1_FishBarrierPorosity_FinalReport.pdf

Although the swimming abilities of different species may be estimated, it can still be difficult to predict how different fish will react to a particular obstacle. Natural waterfalls can have a complicated structure and may be separated into shorter sections or steep chutes which do not require a vertical leap. Water depth below obstacles is also of critical importance in determining the maximum leaping height. Other important factors include water temperature and the size of the individual fish.

Obstacles are also often seasonal, only being passable at particular flows. Many waterfalls are impassable during low flows because the vertical distance is too high, or the water depth too low to allow efficient leaping or burst swimming. On the other hand, many falls are also impassable during the highest flows, when the current speed is too strong for fish to swim against. It is therefore important to assess barriers at a range of flow conditions, and SEPA will require photographs of obstacles under different conditions to enable the application to be determined. In cases where the significance of obstacles cannot be satisfactorily determined from photographs alone, SEPA may require supporting fish survey information to support the application.

Together with partner agencies from the UK and Ireland, SEPA has commissioned work to produce a detailed survey protocol for assessing the significance of natural and artificial barriers to fish. The first part of the work has been completed and is now available on the internet. The report includes a useful review detailing the swimming abilities of all key species: www.sniffer.org.uk/Webcontrol/Secure/ClientSpecific/ResourceManagement/UploadedFiles/SEPA_WFD111_Phase1_FishBarrierPorosity_FinalReport.pdf

3 Semi-quantitative and quantitative methods of fish population assessment

Fish population assessments should be made by electro-fishing. All electro-fishing surveys should follow the SFCC protocol and guidelines[1] therein. Fish surveys should take place between the start of July and the end of September.

Semi-quantitative assessments involve determining what species of fish and what age classes are present. The preferred method is a single electrofishing pass of a measured area and this provides a minimum estimate of the densities of each species and age class. Relying on a single electro-fishing pass means that catch efficiency cannot be quantified, so absolute fish densities cannot be calculated. This method allows a larger number of sites to be surveyed for a given manpower input, as the time spent at each site is reduced. There is also a timed electrofishing protocol, when the catch is referenced to the fishing time, rather than to the area fished.

The larger the area covered and the longer the time a site is surveyed, the greater the chance that a species or age class will be found if it is present. The electro-fishing survey should therefore cover representative areas of all of the main habitat types in the area that are likely to be frequented by the target species. A survey at each site should cover an area of at least 100m^2. The number of sites should be appropriate to the length of stream or river in question. Site selection should be guided by the information in the habitat report. Where possible, sites should be chosen to coincide with sites where hydrological data was collected and where reference photographs were taken. Reference control sites above and below the proposed scheme should also be included.

[1] www.sfcc.co.uk/protelf.asp

Quantitative assessments require the enumeration of a stock or stock component within a given site. An estimate of the total population of each species and age class at the site is made through depletion sampling, where fish are removed from a site in a series of successive electro-fishing passes. Three runs will normally be sufficient for this purpose, provided that a minimum efficiency of 50% is achieved in each pass. The population estimate should then be made using a maximum likelihood estimation procedure. The model used should be stated and will usually be either the maximum likelihood estimator described of Zippin (1956) or the weighted maximum likelihood estimator described by Carle and Strub (1978).

For fully-quantitative assessments, efforts should be made to maximise site isolation using both upstream and downstream stop-nets, and to fish appropriately sized sites to ensure significant depletions (normally an area of at least 100m^2). Both areas should be recorded in the data sheets and included in the final report.

The number and location of electrofishing sites should be appropriate to the length of habitat which is likely to be impacted. Site selection should be guided by the information in the habitat report. Where possible, sites should be chosen to coincide with sites where hydrological data was collected and where reference photographs were taken. Reference control sites above and below the proposed scheme should also be included.

Annex C Information on protected species

1 How to identify potential lamprey habitat in Special Areas of Conservation

The life cycle of all three species of lamprey (the brook lamprey *Lampetra planeri*, the river lamprey *Lampetra fluviatilis* and the sea lamprey *Petromyzon marinus*) found in the UK includes a sedentary larval stage during which the juvenile lamprey (known as ammocoetes) remain buried in areas of sandy silt in the margins of rivers and streams. The duration of the larval stage and so length of time that immature lamprey remained buried differs between the species; brook lamprey may remain in their nursery habitat for approximately six and a half years, river lamprey for three to five years and sea lamprey for approximately five years. However, the habitat preferences of the ammocoetes of all three species are the same:

- Optimal habitat for juvenile lamprey is defined as stable fine sediment or sand ≥15cm deep with low water velocity and the presence of organic detritus.
- Sub-optimal habitat for juvenile lamprey is defined as shallow sediment, often patchy and interspersed among coarser substrate.

There is an emerging school of thought that sea lamprey ammocoetes may also occupy habitat in deeper areas of water, but that research into this is ongoing. The likelihood of lamprey habitat existing in still water bodies, significantly in the vicinity of points where flowing water enters or leaves, should not be overlooked.

Areas of optimal habitat are likely to support relatively high abundances of lamprey ammocoetes that underpin the long-term sustainability of the river or stream's population. However, the significance of areas of sub-optimal habitat, for the distribution of lamprey within a catchment for example, should not be underestimated.

Optimal or sub-optimal habitat is likely to occur in slower flowing reaches of rivers and streams, or in the margins of faster flowing reaches, where under normal flow conditions relatively low flow velocities result in accumulations of fine sediment. Man-made structures such as bridges with abutments and/or piers in the channel may provide suitable hydraulic conditions for the development and long-term maintenance of lamprey habitat. Highly localised areas of suitable habitat may also develop in the lee of in-stream obstacles such as boulders and fallen trees. In such situations, high flows may alter the exact location of lamprey habitat within a reach; high flows may partially or completely remove it or lead to the development of entirely new areas. The location and extent of lamprey habitat may therefore vary with time, and thus emphasise the need for up-to-date survey information.

Adult lamprey require suitable holding areas and clean spawning gravels, similar to those used by spawning salmonids during their freshwater phase. In the absence of up-to-date lamprey habitat information for the stretch of river that would be directly or indirectly affected by a proposed hydropower scheme, a walkover survey to identify areas of potential juvenile (and adult) lamprey habitat should be undertaken. The survey should be conducted in normal flow conditions. Areas that appear suitable should be labelled accordingly on a hard copy map as 'optimal' or 'sub-optimal' and their position recorded using a GPS. This information may be used subsequently to direct the effort of any electric fishing survey for lampreys.

Areas of potential lamprey spawning habitat that might be affected by the development and/or operation of a hydropower scheme should also be labelled on the aforementioned hard copy map and their position recorded using a GPS. Spawning habitat requirements and timings are different for each of the three species and details are given in Natural England's document *Ecology of the River, Brook and Sea Lamprey*: http://naturalengland.etraderstores.com/NaturalEnglandShop/IN104

Anecdotal evidence of spawning activity may, in some instances, be available and this can be used to direct initial sampling effort.

2 How to undertake a semi-quantitative electro-fishing survey for lampreys

The sedentary larval stage of lamprey life cycles provides the best opportunity for sampling to determine presence/absence and abundance data. For the purposes of assessing the likelihood of impacts from the development and/or operation of hydropower schemes, a semi-quantitative survey will suffice.

The areas of optimal and sub-optimal habitat identified during a walk-over survey should be targeted. The electric fishing technique used to survey lamprey ammocoetes differs from that used for other fishery surveys and the Natural England document *Monitoring the River, Brook and Sea Lamprey* should be referred to for exact details: http://naturalengland.etraderstores.com/NaturalEnglandShop/IN104

In each distinct area of optimal or sub-optimal habitat surveyed, the species and length in millimetres of any captured ammocoetes should be recorded. Note that because of the difficulties associated with differentiating between *L. planeri* and *L. fluviatilis* in the field, it is accepted that data for these species will be recorded as simply *Lampetra* sp. A key for lamprey identification is provided in the Natural England document *Identifying Lamprey: A Field Key for Sea, River and Brook Lamprey*:
http://naturalengland.etraderstores.com/NaturalEnglandShop/IN108

The area (in m^2) of each distinct sampling location should be recorded to enable the calculation of minimum density estimates (individuals/m^2).

The species and habitat data gathered from each sampling location should usually just be recorded using the type of proforma shown in Appendix 1 of the aforementioned English Nature document.

3 How to undertake a survey for freshwater pearl mussels

Standard survey methods have been developed for this species through a number of previous projects funded by Scottish Natural Heritage. These have been adapted for more site-specific projects and the following is a full version of methods for employing at specific sites.

Licensing and access permission

Freshwater pearl mussels are fully protected under the Wildlife and Countryside Act (1981). Therefore all surveyors must be licensed by SNH. Surveyors must have secured access permission from land owners before any fieldwork is undertaken. Given the ongoing threat that illegal activity, including pearl fishing, poses to freshwater pearl mussels it is considered good practice that surveyors notify the nearest police station about their survey prior to going out on site. For more information about illegal activity affecting pearl mussels, and what to do if any is detected, visit the SNH website: www.snh.org.uk/pubs/detail.asp?id=1365

Health and safety

All surveyors will have legal responsibilities under the Health and Safety at Work Act to ensure the health and safety of their employees and any other person who may be affected by their actions or omissions. All surveyors should be trained in safe working practices. It is recommended that surveyors work in pairs, and that they each wear a life jacket and thigh waders (to discourage work in deeper, fast-flowing water) and use a special wading and mussel gathering staff.

Field season

Survey work can only be undertaken in periods of low water flow. On larger rivers, opportunities for survey work can between October and March may be limited.

Site selection

The length of river to be surveyed will vary depending on the nature of the proposed project. Where there is river engineering proposed (such as bank protection or work on the river bed), then typically it will be the area of river bed directly affected by the project, together with a minimum of 0.1km upstream and 0.5km downstream which may be indirectly affected (the 'survey site'). Where a development will result in reduced flows over a river reach, the length of the affected reach (the 'survey site') should be surveyed for the presence of freshwater pearl mussels.

Survey of the area likely to be directly affected by proposed engineering project

The entire river bed should be surveyed in this part of the survey site. This can be done by laying out a 1m x 1m grid, and counting and measuring all mussels in each grid square. Searches for hidden and juvenile mussels should also be carried out in 20% of the squares in which visible mussels are recorded.

Survey of the downstream area likely to be indirectly affected by proposed project

A general survey of the river and its substrate types within the survey site should be made, by walking along the river bank and/or by wading in the water. The aim is to identify specific areas that are most likely to harbour mussels, by using information on their habitat preferences from previous studies and experience. Information on the habitat preferences of mussels is from Natural England's document *Ecology of the Freshwater Pearl Mussel*, but it is important that surveyors have past experience of working with freshwater pearl mussels: http://naturalengland.etraderstores.com/NaturalEnglandShop/Product.aspx?ProductID=3211a435-9d7c-4695-8a0a-169708f0830b

Once the surveyor has found a suitable area, they should enter the river at the nearest point and conduct a search, concentrating on the most favourable substrate types so as to optimise search efficiency. To ensure compatibility with other surveys, they should search:

- using a glass-bottomed viewing bucket;
- under favourable conditions, ie bright light, clear water, low flow regime;
- in water sufficiently shallow for safe wading;
- in an upstream direction, checking favourable sites, eg in the shelter of cobbles, boulders or overhanging banks;
- by moving loose debris and trailing weed gently aside, but without disturbance of the river bed.

Negative results

If the surveyor doesn't find any mussels in a specific search area, they should move the search to other suitable areas within the survey site. Even if they do not find mussels anywhere in the survey site, the surveyor should still record site information on a standard recording form as described below. A copy of the standard recording form is available in Appendix A of Natural England's document *Monitoring the Freshwater Pearl Mussel*: http://naturalengland.etraderstores.com/NaturalEnglandShop/Product.aspx?ProductID=650cd48a-58a8-4761-870d-f72cb4104a51

Positive results

If the surveyor finds a live mussel or dead shell, then they should conduct a systematic search as follows:

Within the area where mussels are found, one transect 50m long by 1m wide should be searched, and laid out so as to traverse the main area of suitable habitat. If an initial search of the whole transect indicates that there are likely to be fewer than 250 mussels, all mussels should be counted.

If there are too many mussels in the transect to count accurately (ie >250), 1m x 1m quadrats should be laid at 10m, 20m, 30m, 40m, and 50m intervals. Counts and measurements of the mussels in these five quadrats are used to provide an extrapolated estimate for the whole 50m transect.

At 10m, 20m, 30m, 40m, and 50m along the transect, a 1m x 1m quadrat is laid on the substrate. All mussels visible within the quadrat mussels are counted and then removed (to be replaced in the same quadrat later). Loose stones and debris are then dislodged to reveal any hidden mussels and, in particular, to search for any juveniles. All these mussels are measured along their longest dimension to the nearest 1mm (using dial callipers). Measurement of the mussels allows a size/age profile to be produced. It is particularly important to establish whether juvenile mussels are present, indicating active recruitment at that location. A pearl mussel is considered 'juvenile' if it is ≤65mm long; mussels ≤30mm long are likely to be under five years old and their presence is especially important as they indicate recent recruitment.

For each 50m transect, site details are recorded on a standard recording form. These include:

- an eight-figure grid reference;
- average width and depth(m);
- substrate composition (based on the widely used Wentworth Scale);
- main types of adjacent land-use, bankside vegetation, evidence of impacts;
- details of any discussions with local people concerning the river.

At least one photograph should be taken to indicate the position of the transect in relation to the river bank.

Standard abundance terms

The surveyor should report rusing the following abundance categories:

No. of live mussels per 50m x 1m transect	Abundance level
0	E
1 - 49	D
50 - 499	C
500 - 999	B
≥1000	A

Spreadsheets

The surveyor should provide a spreadsheet form that is compatible with existing spreadsheets containing pearl mussel data. Therefore it is suggested that they should provide the following data:

- mussel numbers in each 50m transect:
  - sampling point code;
  - date;
  - grid reference;
  - no. live mussels in each quadrat and total transect;
  - no. dead shells;
  - % of juvenile pearl mussels (≤65mm) in each 50m transect;
  - no. pearl mussels ≤30mm in each 50m transect etc.
- measurements of pearl mussel shell dimensions:
  - sampling point code;
  - date;
  - measurements.

They should also supply similar information for any area of riverbed that will be directly affected by a proposal.

A notes column should also be provided in the above spreadsheet, including information about potential or actual threats, particularly evidence of recent, illegal pearl fishing, and management issues which may be relevant to the pearl mussel population. Any juvenile salmonids observed during pearl mussel surveys should also be recorded in the 'notes' column.

Summary habitat information principally describing the river width, water depth, and substrate types (linked to the sampling point code and grid reference), should also be included as a separate spreadsheet.

Deep water survey

A technique has been developed for surveying visible mussels in deep water (>1m). Information is available from SNH: www.snh.org.uk/pubs/detail.asp?id=950

4 How to undertake a survey for otters

Otters are widespread in Scotland and may occur is any watercourse, including small upland burns. An otter survey should therefore be carried out in relation to any hydro-electric development.

The survey should cover the whole of the development site, focussing on:

- the riparian zone along any of the watercourses that will be affected by the development;
- the margins of any affected areas of standing water;
- the footprint of any areas that will be inundated as a result of the development and where any new infrastructure such as access roads and turbine houses are proposed.

The survey should extend 250m both upstream and downstream of the development site, on both sides of the watercourse. It is important that all otter shelters and resting places are identified; these often occur close to the water, but also in sites such as reed-beds, peat hags, or in piles of rocks (including rock-amour) some distance from open water.

Where a new access road is proposed, the survey should extend at least 100m upstream and downstream of any watercourse crossing points to ensure that the final route does not impact on otter shelters or, if this is unavoidable, that a licence is sought from the Scottish Government and appropriate mitigation put in place.

Surveyors can conduct an otter survey at any time of year, but if water levels are (or have recently been) very high, or if there was heavy rain the week before the survey, it may need to be repeated. This is because signs of otters may have been lost, giving a false indication of their absence.

The surveyor should record all evidence of otter activity within this area. They should concentrate on the margins of the watercourse/loch and immediate bank-side habitats up to 10m from the water, and search this zone thoroughly. Wading may be necessary to examine features such as root cavities and over-hanging vegetation.

The type of habitat and its value for otters should be recorded. Signs of otters include spraints (droppings), anal jelly, footprints, paths, slides, holts (underground structures), 'lie-ups', above-ground resting sites ('couches') and feeding remains. Particular care should be taken to survey under and around bridges for otter spraints and tracks, as they are often found in these locations. These signs should be mapped, preferably using a hand held GPS unit. Otter sightings are unlikely, but should be recorded.

Areas of mud and soft sand are ideal for finding footprints. Spraints are often found in conspicuous places such as ledges or stones under bridges, rocks/boulders mid-channel, and on prominent rocks and grassy hummocks.

Otters frequently use the same sprainting and feeding sites on a regular basis, and the locations of all signs (spraints, feeding remains, tracks, etc) should be recorded. Regular sprainting sites such as mossy boulders often show brown 'burn' marks due to the frequent presence of spraints. In moorland areas, particularly near the coast, traditional spraint sites can appear as small bright-green grassy mounds, due to years of nutrient enrichment.

Crevices, overhangs and open rock structures (either man-made or natural) are often favoured by otters as lying up sites. Check any rock casings, ruined buildings, bridge structures, overhanging heather-covered banks etc for resting sites and associated signs of otter presence.

Any so-called 'potential' holts or lying-up places that may be affected by the proposed works (within 30m), should be investigated further, or the proposed scheme modified such that they will not be affected in any way. The term 'potential holt/shelter' is not helpful in respect of licensing consultations and should be avoided in this context. A potential holt or shelter has no legal protection as, by definition, there is no confirmation of otter usage. Otter holts/shelters are not always marked with spraints and if these structures are discovered during a survey and don't show any other signs of current otter use then they may be categorised as potential holts, but remain unprotected unless further survey confirms otter use. Where such features are identified, the surveyor is advised to undertake a repeat visit at least three months prior to any work commencing on site, to enable a licence to be applied for and processed, should evidence of occupancy come to light. If occupancy cannot be demonstrated, it is clearly best practice to avoid unnecessary damage.

In some cases further detailed information may be required, for example determination of breeding in the area. In this case surveyors can set out sand traps for footprints to identify whether young otters are present. It should not normally be necessary, but where further information on otter holts is needed, lights or an endoscope can be used to view inside the structure. In this case, the surveyor should contact SNH for advice about the need for a licence.

What should be included in the survey and mitigation report?

In many cases, the report need not be a long one, but the following should be included within a competent survey:

- a one-page executive summary;
- the date/s and the amount of time spent in the field;
- the weather conditions and any relevant water levels/ground conditions;
- the qualifications and/or experience of the surveyor;
- a summary of the legal protection afforded to otters;
- large-scale maps showing the area searched including any limitations, such as access restrictions;
- photographs of otter holts or other key areas;
- locations of any signs of otters or otter sightings;
- locations of otter holts or resting places;
- a summary of any signs of otters found, and its importance in terms of the known otter distribution for the area;
- the potential impact of the development on otters;
- recommended mitigation proposals;
- a summary of residual impacts (ie what would the impacts be if the mitigation is adopted?);
- as the otters are an European protected species, a recommendation on whether a licence application needs to be made to the Scottish Government, based on the summary of residual impacts.

5 How to undertake a survey for water voles

Although water voles are widespread throughout Scotland, their distribution is patchy with most animals now thought to be restricted to upland/peatland habitats. They are not present on most of the off-shore islands[2]. Upland sites should always be considered for survey in relation to hydro-electricity developments.

The survey should be designed cover all suitable habitats within the development site, focussing on:

- the riparian zone (up to 10m from the water) along the watercourses (including ditches) that that will be affected by the development;
- the margins of any affected areas of standing water;
- the footprint of any areas that will be inundated as a result of the development and where any new infrastructure such as access roads and turbine houses are proposed.

An initial desk survey should be undertaken to identify whether the species is likely to be present on or near the development site. The Local Record Centres and the National Biodiversity Network can provide some information on water vole distribution: www.nbn.org.uk

There are also two national surveys of water voles, published by the Vincent Wildlife Trust in 1993 and 2003. More information on water voles is available in the SNH on-line publication *Conserving Scotland's Water Voles*: www.snh.org.uk/publications/on-line/wildlife/voles/default.asp

For large-scale hydro-electric developments, a trawl should be made for information on the site and a radius of 2km around the development.

[2]A notable exception is the group of Reisa islands in the Sound of Jura, where water voles can be found at very high densities.

If the desk study suggests that voles may be present, a more detailed survey should identify the location of any water vole burrows and associated habitat, and thereby inform the design and location of the scheme to minimise any impacts. In upland areas, the use of a GIS can be invaluable in selecting areas for survey, provided data on slope and soil type (presence of peat) are available.

If evidence of water voles is found, ideally the survey should place the site in the context of the wider population: is it part of a larger (meta) population, or is the colony on the development site the only population in the area? Finally, if mitigation is required, the survey should provide a baseline for further monitoring. Water vole colonies that are located around the margins of lochs prone to water level fluctuations (as a result of proposed hydro-electric development), are particularly prone to impacts and will require carefully planned mitigation and monitoring.

Water voles have specific habitat requirements and their distribution is heavily influenced by the presence of feral American mink, such that the two species rarely coexist at the same locality. In upland areas, their preference is for peat-dominated flat or gently-sloping areas, usually <3% gradient. Sections of watercourse with an average gradient of >10% can be excluded from the survey, as can sections dominated by a rock substrate or where the banks are predominately stony and unsuitable for excavating burrows. In lowland areas water voles tend to be restricted to small watercourses, often overgrown drainage ditches, but other areas of slow-flowing or standing water with dense bank-side and marginal vegetation may be used if mink are rare or absent in the area.

With the exception of those areas initially eliminated as unsuitable for water voles, the whole of the development site should be surveyed. For small sites, an extra 50m upstream and downstream of the development should be surveyed. For larger schemes affecting several 100 metres (or kilometres) of riparian habitat that result in noticeable water level fluctuations and lead to population fragmentation and habitat loss, it would be appropriate to survey for 500m both upstream and downstream of the site.

Water vole surveys rely on the signs of the animal. These include droppings, latrines[3], feeding stations (with leaves and stems which have been eaten off at each end), burrows with grazed 'lawns', above ground nests, paths and footprints. Sightings are unlikely but should be recorded.

It is possible to calculate indices of abundance from latrine counts, however the relationship between the population index and latrine counts varies according to habitat type, see page 76 of the SNH report *The ecology and conservation of water voles in upland habitats*: www.snh.org.uk/pubs/detail.asp?id=460

Therefore, the mathematical function used to derive population size from latrine counts must be appropriate for the particular geographical area or habitat type concerned. Ideally, latrine counts should not be undertaken within two weeks of heavy rainfall.

Water voles can move seasonally from place to place, so any old signs of their presence should be recorded. Their signs are most obvious when they are breeding, so surveys should be carried out during this time. Surveys in the lowlands can be undertaken between April and October. In upland areas, surveys are not recommended before May or after September, the optimum months being June-August inclusive. In some cases, it is preferable to survey twice – once early in the season, and once near the end, to get a more comprehensive result. The survey should be carried out in good weather as flooding or heavy rain will remove signs that water voles are present.

Survey work should normally include both banks of a watercourse, unless there is a good reason why this is not necessary. Water voles can temporarily abandon a site if it is disturbed, so survey works immediately after ground disturbance should be avoided.

The watercourses should be split into 500m lengths. For each length, the location of field signs should be recorded, and ranked abundant, frequent, scarce or none. The number of latrines should be counted.

Special attention needs to be given to detecting water vole signs in upland areas as the animals may frequently occupy very narrow watercourses (<1m in width) and even subterranean channels through the peat. Signs can frequently be obscured by overhanging vegetation and so a very thorough search is required.

[3]A latrine is defined as more than one dropping.

Photographs 1 and 2: Examples of good water vole habitat

Photograph 3: Example of unsuitable water vole habitat (but still likely to be used by otters):

Further information on water vole surveys refer to:*Water Vole Conservation Handbook. Second Edition. Strachan, Rob, and Moorhouse,Tom. Wildlife Conservation Research Unit. 2006*

What should be included in the survey and mitigation report?

A competent survey should include the following:

- a one page executive summary;
- the date/s and the amount of time spent in the field;
- the weather conditions and any relevant water levels/ground conditions;
- the qualifications and/or experience of the surveyor;
- a summary of the legal protection afforded to water voles and the practical implications of this;
- large-scale maps showing the area searched, including any limitations, such as access restrictions;
- photographs of any water vole evidence;
- locations of water vole signs, sightings, and their burrows;
- a summary of any water vole evidence found and its importance in the context of the wider meta-population in the area;
- the potential impact of the development on water voles;
- recommended mitigation proposals;
- summary of residual impacts (ie, what would the impacts be if the mitigation is adopted?);
- details of any checks of information from Local Record Centres, the National Biodiversity Network, or other sources;
- a count of water vole latrines for each 500m section surveyed;
- locations of signs of mink;
- a map and description of the habitats, including the substrate of the banks of the water courses and the shore of lochs;
- the depth, width and current of the water courses.

Annex D Information on landscape interests

The following general SNH guidance will assist an application in preparing an environmental statement:

- *Renewable Energy Consultations: A Service Level Statement* sets out the levels of engagement that SNH may offer the applicant/their consultants at various stages of the development process: www.snh.org.uk/strategy/renewable/sr-re02.asp
- *Advice Note - Interim Guidelines on the environmental impacts of hydroelectric schemes* is available on request from SNH. (Note: these interim guidelines replace the *Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydroelectric Schemes* from February 2001).

Annex E Glossary of terms

Term	Meaning
Compensation flow	A minimum release of water below a reservoir/loch in order to provide for environmental mitigation.
Flow duration curve	A graph showing the percentage of time that the flow exceeds certain long-term values.
Hands off flow	The minimum residual flow at any time down the stretch of river between the intake and the outfall, when generation is taking place.
Installed capacity	The total maximum output (kw) of the turbine/s.
Kilowatt (kW)	A unit of power, equal to 1000 watts.
Megawatts (MW)	A unit of power, equal to 1000 kilowatts.
Gigawatt (GW)	A unit of power, equal to 1000 megawatts.
Load factor	The ratio of energy generated in comparison to the potential generation if the scheme runs at full capacity for the whole year.
Penstock	A pipe that conveys water from the intakes to the powerhouse.
Mitigation flow	The remaining flow left downstream of an intake when abstraction takes place. Usually variable and above hands off flow as levels change.
Q95	The flow rate that is exceeded 95% of the time.
Residual flow	The remaining flow left downstream of an intake when abstraction takes place. Varies above the hands off flow as levels change.
Tailrace	The pipe/channel that delivers water back to the environment after being passed through the turbine.
Freshet	A volume of water which is released from storage reservoirs/lochs at a higher rate than compensation flow to mimic higher flow conditions. They generally last for at least a 24-hour period. They are primarily for fish and ecology purposes.
River	Term used in text for any size of watercourse.