Water Use

Supporting Guidance (WAT-SG-74)

Sector-specific Guidance: Hydropower

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Copyright and Legal Information

Update Summary

Version	Description
v1	First issue for Water Use reference using approved content from the following documents: *WAT-SG Sector-specific guidance Hydro.doc*
v1.1	Numbering revised for section 4 headings
v2.0	Expired CMS links reviewed and updated.
v3.0	Section 5 Mitigation Flow Checks inserted

Notes

References: Linked references to other documents have been disabled in this web version of the document. See the References section for details of all referenced documents.

Printing the Document: This document is uncontrolled if printed and is only intended to be viewed online.

If you do need to print the document, the best results are achieved using Booklet printing or else double-sided, Duplex (2-on-1) A4 printing (both four pages per A4 sheet).

Always refer to the online document for accurate and up-to-date information.

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1. Purpose

This document is intended to provide sector specific guidance for SEPA staff involved with the determination of applications for licences under CAR relating to all new hydropower schemes. This document does not cover licence reviews. It is intended to compliment more generic documents such as *WAT-RM-01: Regulation of Abstractions and Impoundments* and *WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment*.

This document should be used in conjunction with:

- *Guidance for applicants on supporting information requirements for Hydropower applications*. This document will eventually include specific details for low head and storage hydropower schemes.
- *Guidance for developers of run-of river hydropower schemes*

2. Background

At the date of issue of this guidance there are over 180 hydro schemes of varying size around Scotland. They range from massive cross catchment schemes like the Tummel, Conon or Sloy schemes to small domestic supplies for houses or estates. These schemes can make an important contribution to the generation of renewable energy in Scotland and need to abstract substantial amounts of water to do so. The majority of schemes are connected to the national grid and are commercial ventures.

Hydropower developments must also obtain development consent from the local authority or Scottish Ministers and this issue is covered in the *Guidance for applicants on supporting information requirements for Hydropower applications*.

3. Operation of a Hydro Scheme

3.1 Components of a Hydro Scheme

The main components of any hydro scheme are intakes, turbines, returns, fish passes and screens.

The **British Hydropower Association** has as very useful mini hydro guide that provides some background reading and information regarding the above components and details regarding installation of small hydro schemes. See *A Guide to UK Mini Hydro Developments*.

Further information can also be found in *WAT-SG-28: Good Practice Guide - Intakes & Outfalls*.

WAT-RM-01: Regulation of Abstractions and Impoundments contains information in Appendix 3 on types of fish and eel passes.

3.2 Types of Hydro Scheme

There are three main types of hydro scheme namely:

- Run-of-river (including low-head and high-head schemes)
- Storage
- Pump Storage

3.2.1 Run-of-river schemes

- Divert part of a river's flow down a pipeline (penstock) to a turbine.

Run-of-river schemes utilise the natural flow and elevation drop (head) of a river to generate electricity. They do not have any notable storage and are reliant on river levels to generate energy. These often only have one abstraction and impoundment feeding into the pipeline (penstock) which runs adjacent to the river channel. The water passes through the turbine and is then returned back to the river.

Run of river schemes will form the majority of new hydro applications.

Figure 1. Schematic of a typical Run-of-River hydro scheme

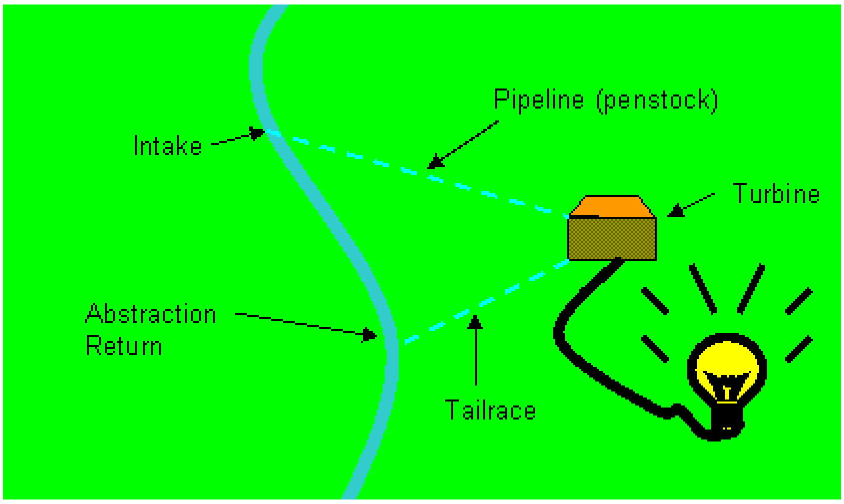
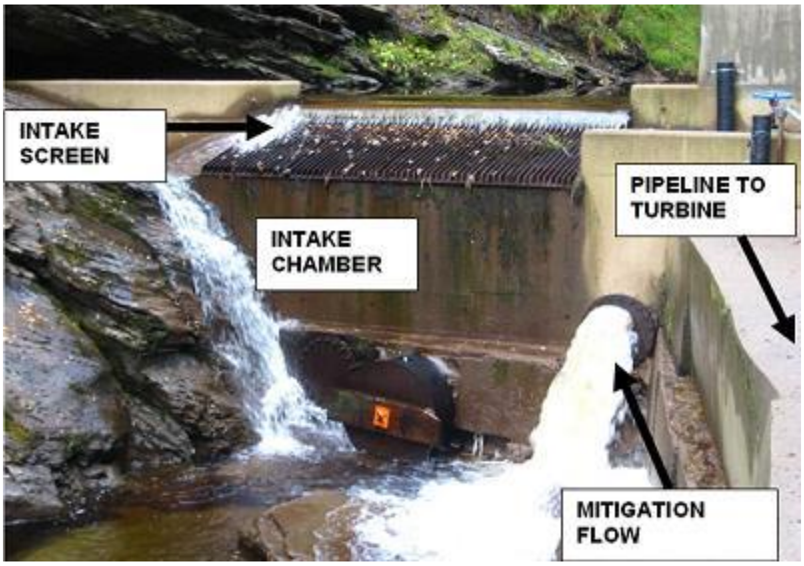


Figure 2. Typical Run-of-River intake



Run-of-river hydro schemes in the UK can be separated into two main groups: low-head and high-head.

Low-head schemes operate over a relatively short vertical drop, and therefore usually require large volumes of water to provide sufficient potential energy for power generation.

High-head schemes require less water due to the greater vertical difference between the intake and outfall locations. These are generally built on smaller tributaries and have a greater distance between the intake and outfall. They therefore usually involve abstracting water from a substantial length of watercourse.

In Scotland, the vast majority of run-of-river hydro scheme applications to date have been high-head schemes. However there has been a significant increase in the number of applications relating to low-head schemes.

3.2.2 Storage schemes

Storage schemes either increase the storage in existing lochs (raised lochs) by adding an impoundment (dam) or impound watercourses to create the storage. The stored water is then used when required. By doing this an operator can generate on demand and also store water during the wetter months to be used all year.

Figure 3. Schematic of a storage scheme with catchment transfers (A- F are abstraction points)

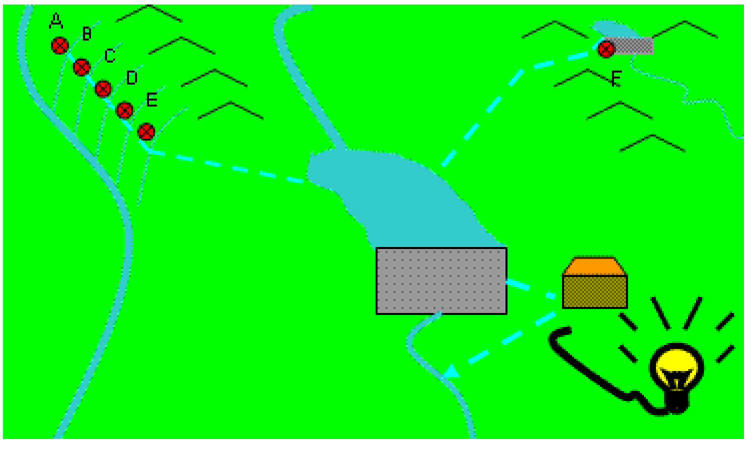
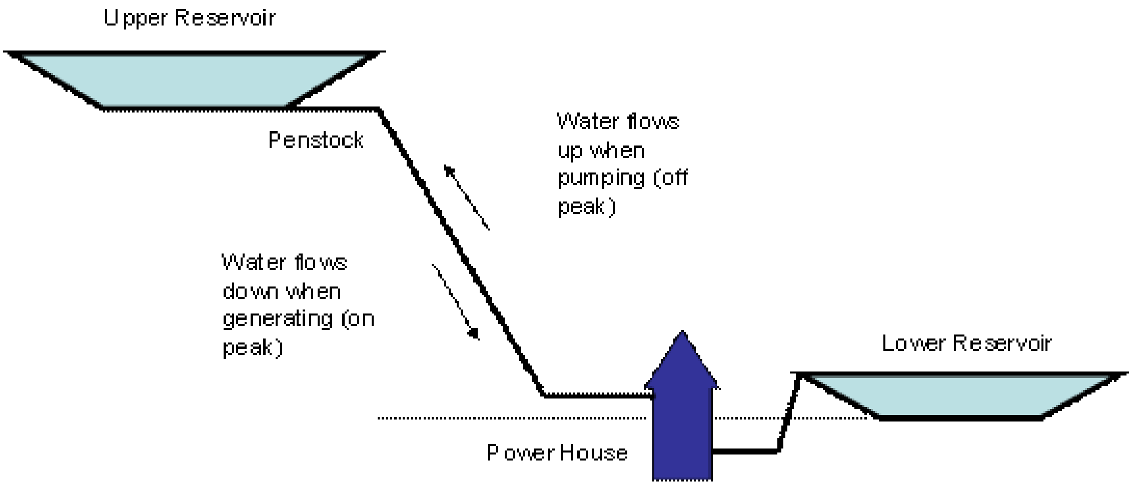


Figure 4. Loch Glascarnoch Storage Reservoir (Highlands)

3.2.3 Pump Storage schemes

This scheme produces energy by transferring water from an upper reservoir or raised loch to a lower reservoir or loch during periods of high demand. During periods of low demand, when energy prices are low, the water is then pumped back up to the upper reservoir/ loch.

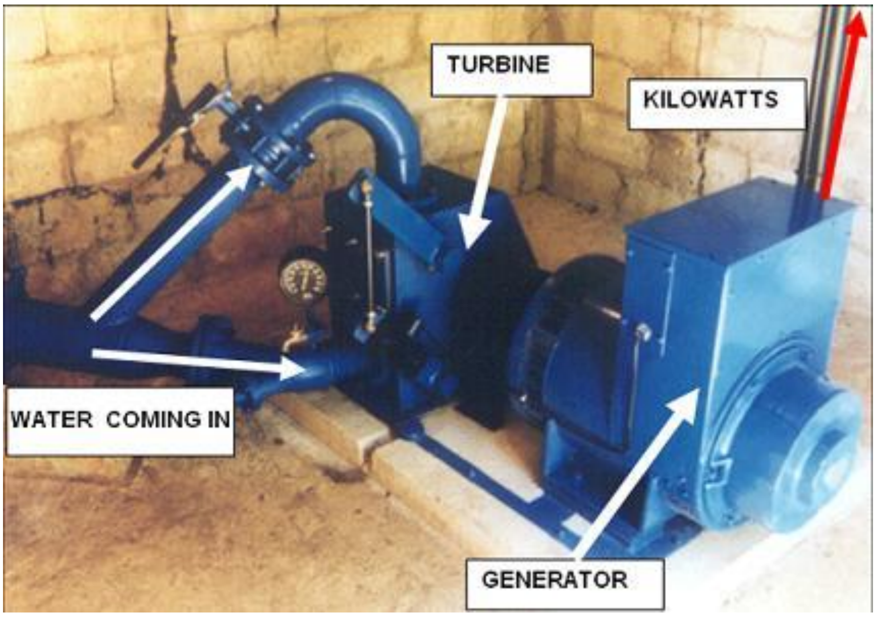
Figure 5. Schematic of a pump storage scheme

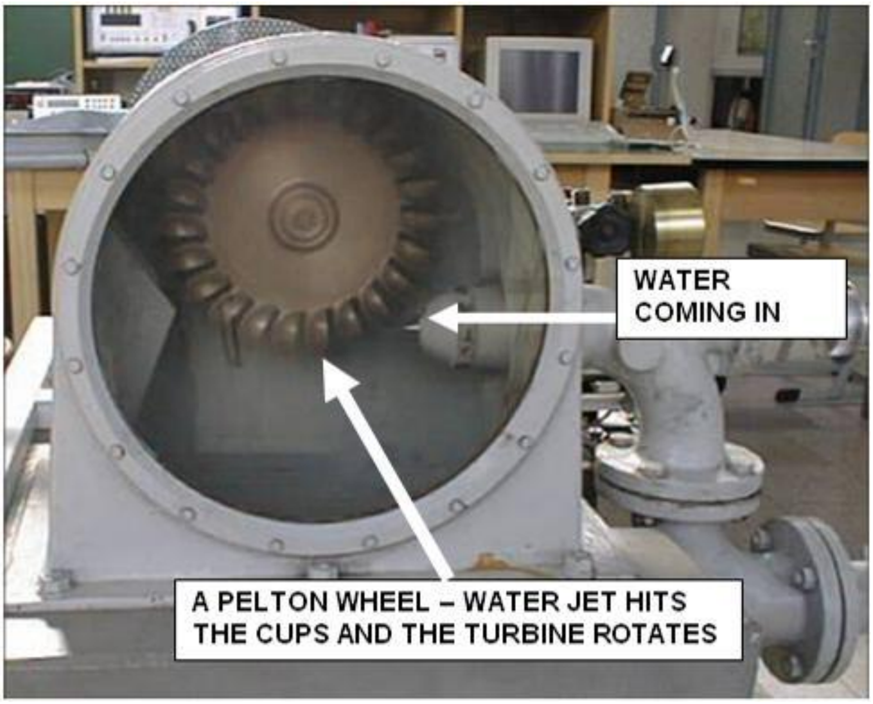


3.3 Energy Production

Energy is produced as water passes through a turbine. The turbine rotates under pressure from the incoming water and drives a generator producing electricity.

Figure 6. Two views inside a typical turbine





3.3.1 How Much Electricity Does a Hydropower Scheme Produce?

Electricity is measured in kilowatts or megawatts (1 MW = 1000 kW). A typical domestic fan heater uses 2 kW per hour of energy.

A 100 kW scheme has the potential to supply power to approximately 50 homes. A scheme the size of for example Glendoe of 100 Megawatts can supply power to approximately 34,000 homes.

There are various terms in common use for the size of a scheme for example mega, micro and pico schemes. However thresholds for each size of scheme have not been defined therefore SEPA tends not to refer to these terms.

3.3.2 How is the potential Power Output Calculated?

The amount of energy produced by a hydro scheme depends on the following factors:

- The flow of water passing through the turbine
- The head of water passing through the turbine. This is measured as the difference in altitude between intake and turbine
- The hydraulic efficiency of the turbine. This is how much of the potential energy of the flow and head is converted to power output and is expressed as a percentage. The best turbines can have hydraulic efficiencies in the range 80% to 90%

The potential power output can therefore be calculated by the following formula:

$$P\ (kW) = Q\ (m^3/s) \times H\ (m) \times \eta$$

Where:

- P = the power produced (Kilowatts)
- Q = the maximum flow rate passing through the turbine (m3/s)
- H = the effective pressure head of water across the turbine (m)
- η = the hydraulic efficiency of the turbine, expressed as a percentage factor i.e. 7 = 70%.

So a turbine with a maximum flow of 0.5 m3/sec, a head of 150m and an efficiency of 80% could produce:

0.5 x 150 x 8 = 600 kW of electricity

This is known as the rated power output or installed capacity. This is the potential power output based on the maximum abstraction rate. However the maximum flow will obviously not be available all year round.

3.3.3 How is the Annual Energy Production Calculated?

The actual energy produced over the course of a year is usually between 40% and 70% of the maximum potential power output depending on the type of turbine. This is known as the **load factor**. The energy output is measured in Kilowatt hours or Megawatt hours or Gigawatt hours (kWh / MWh/ GWh).

So a 100 kW scheme over the course of a year using a load factor of 40% would produce:

100 (kW) x 8760 (hrs) x 0.4

= 350,400 kWh or 350.4 MWh (or 0.3504 GWh) of electricity

3.4 Economics

3.4.1 How Much Money Does A Hydropower Scheme Make?

The figures and rates used below are indicative only as they are subject to change over time. Correct at date of issue of this document.

Example

COST: The approximate construction costs for a typical 100 kW scheme are shown in Table 1.

Table 1. Approximate construction costs for a typical 100 kW scheme

Item	**Cost**
Machinery	£60,000
Civil Works	£80,000
Electricity Works	£30,000
External Costs	£30,000
Total	**£200,000**

REVENUE: Using the 100 kW example above and based on an electricity unit (kWh) price of 8.5p a scheme this size would make:

350,400 x 0.085 = £29,784 per year.

So the pay back period would be around 6 to 7 years with an expected scheme lifespan of 40 years.

Additional revenue is available for hydropower schemes through initiatives introduced by the Scottish Government:

- Renewable Obligation Certificates (ROCs)
  - Power suppliers have to provide a certain amount of their power from renewable sources (Hydro, Wind, Tidal etc).
  - If they don't meet their obligation they have to pay money for the shortfall.
  - Small scale power producers receive a ROC for each MWh they produce worth around £40.
  - These can then be sold to the power companies. The power produced therefore goes towards meeting their overall obligation.
- Feed In Tariffs (FITs)
  - In force from April 2010
  - FITs are payments made for every kilowatt-hour kWh of electricity generated by renewable sources.
  - Hydropower schemes cannot claim both FITs and ROCs. Schemes less than 50 kW will have to use the FITs and schemes above 5 megawatts can only use the ROCs. Systems between 50kW and 5MW get a one-off choice of FITs or ROCs, but won't be able to change.
  - The level of the payment is laid down by the government, and varies for different renewable energy sources and at different scales.

4. Mitigation

4.1 Background

The potential environmental impacts of both low-head and high-head run-of-river schemes can be complex. Both types of scheme can have an impact on ecology by altering flows within the abstracted reach. These effects can be direct, through a reduction in available wetted habitat, or indirect, for example by reducing the flow available for critical life stages such as fish spawning. Reduced flows may also have an impact on migrating fish, both by reducing the attraction to upstream migrating fish, and by reducing the time period during which flows are suitable for fish to negotiate past obstacles within the abstracted reach. This impact on migration can be particularly relevant to low-head schemes, which are often built on existing weirs on main river channels, at important locations for upstream migration.

To date SEPA has worked with consultees such as Fisheries Committee, Marine Scotland (formerly FRS) and SNH to ensure that mitigation measures are provided to minimise impacts of run-of-river hydropower schemes upon the environment. SEPA will include the applicable mitigation requirements as conditions in the licence for the scheme.

Research is currently underway to focus on examining fish populations in high-head run-of-river hydro schemes, to establish whether a response to the altered hydrological regime can be observed. A range of sites will be included, to enable the impact of various mitigation arrangements to be assessed. This research will form part of a wider UK project, which will also incorporate an assessment of the impact of low-head schemes on migration behaviour at weirs and associated structures. It is also anticipated that future work may build on this project both through the collection of additional long-term fish data, to examine multigenerational effects, and by examining the response of other ecological elements to the range of run-of-river schemes.

Currently the *Guidance for developers of run-of river hydropower schemes* (Part B) contains draft mitigation measures which SEPA considers likely to be practicable to include in run-of-river hydropower schemes. This will be reviewed and updated as scientific knowledge increases.

To aid understanding of the hydrological mitigation measures to protect the water environment this document includes information on delivery of mitigation flows and a full explanation of the flow duration curve.

4.2 How Mitigation Flows Are Delivered

4.2.1 The Orifice

Figure 7. The Orifice

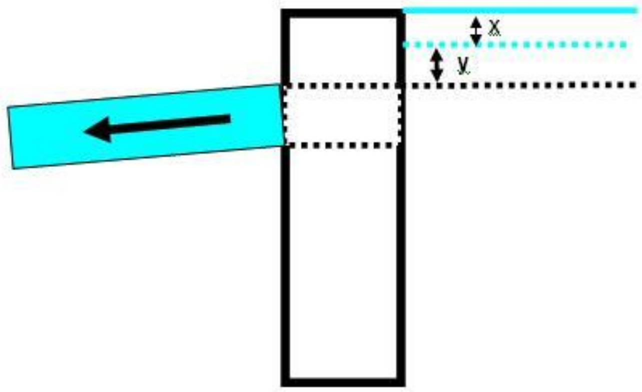
This is a common form of delivering mitigation flows such as hands-off flows from impoundments.

An orifice is a circular hole drilled in the dam wall usually reinforced with a circular metal plate.

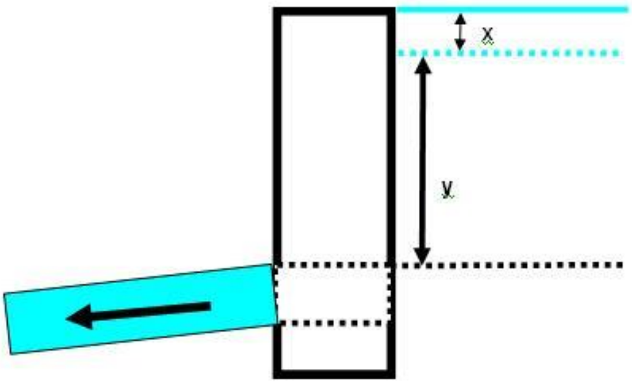
The orifice can be located in the main wall of the dam or, as in this case, the intake chamber wall.

There can be variability in flow above the hands-off flow depending on the location of the orifice:

Figure 8. Flow variation dependant on orifice location



Low head orifice
If the orifice is set high up on the weir it is referred to as a LOW HEAD ORIFICE as the level of water (head) above the orifice will be relatively low compared to the overall depth of water behind the weir.
As the river level rises the proportion of change in head above the orifice is therefore large (i.e. x compared to y)
This means a change in head makes a big difference in flow.
This would give a better variable compensation flow than a high head orifice – see below.

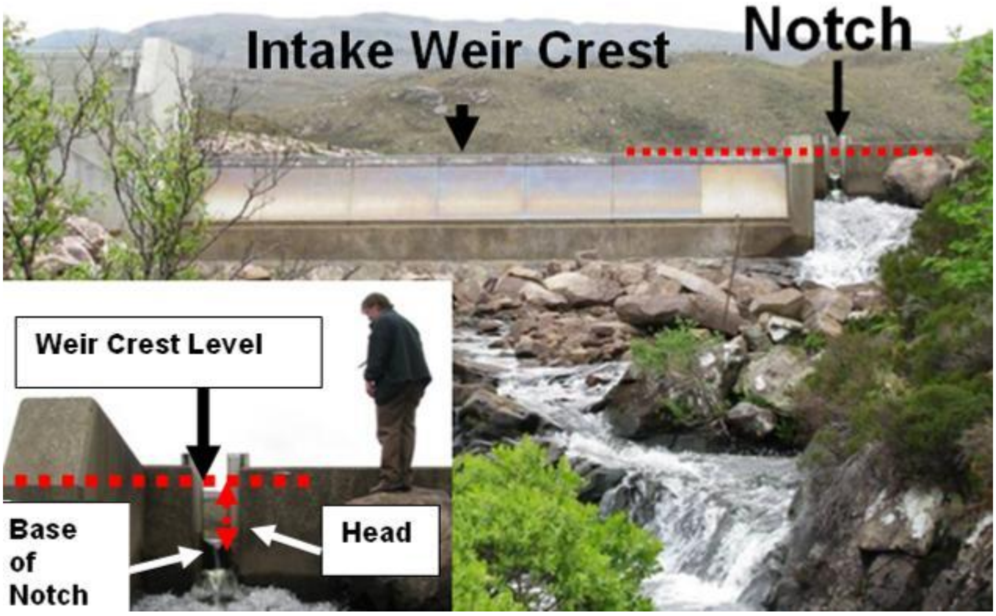


High head orifice
If the orifice is set low down on the weir it is referred to as a HIGH HEAD ORIFICE as the level of water above the orifice is high.

As the river level rises the proportion of change in head above the orifice is therefore low.
This means a change in head makes a small difference in flow.
This would be a less variable compensation flow as river levels fluctuate.

4.2.2 The Rectangular Notch

Figure 9. The Rectangular Notch



The base of the notch is set below the level of the main intake weir crest. This guarantees that water is always provided downstream. The design should ensure that the hands-off flow will be delivered when the water level is spilling over the main weir.

As water level increases the head in the notch also increases and thus provides additional, or residual, flow above the hands-off flow. At maximum abstraction the head of water above the main weir crest is commonly referred to by developers as the “design level” and will be providing the maximum residual flow.

4.2.3 The V- Notch

Figure 10. The V- Notch

This is a less common form of delivering mitigation flows such as hands-off flow. However the same principle applies as for rectangular notches. Again the head would be the difference in height between the base of the notch and the main weir crest. Developers often oversize the notch and then fix on a plate to the agreed size once the mitigation has been agreed as part of the licence determination.

4.3 Flow duration curve explained

Hydrologists often refer to flows in terms of Q95, Q90, Q50, Q5 etc.

These types of values are known as flow exceedences or percentile flows.

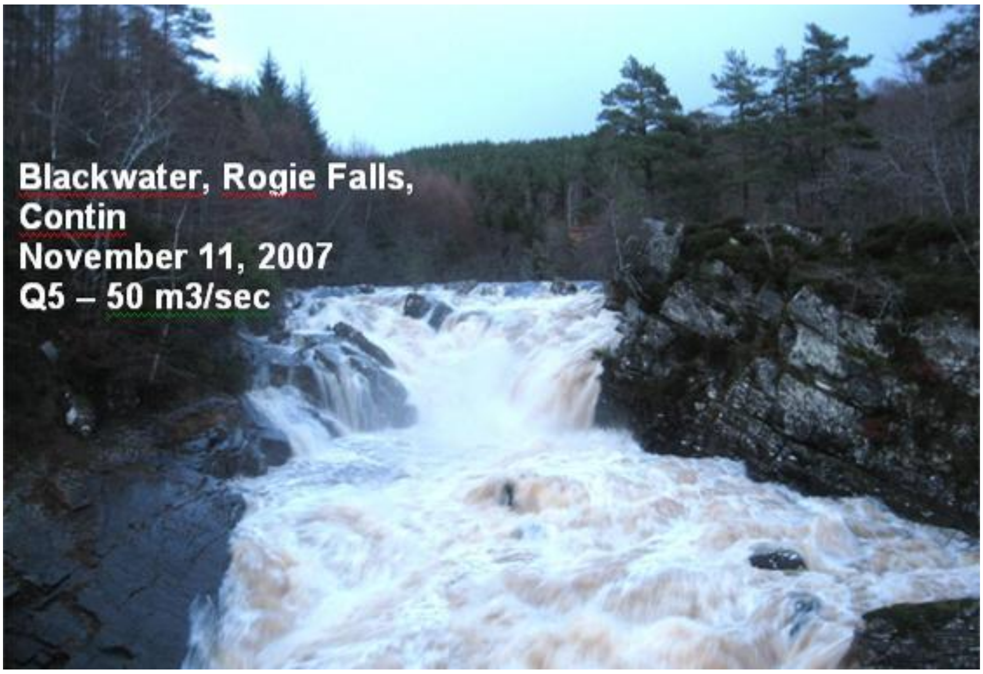
This means for example that a Q95 flow of 1 m3/sec is the flow that is exceeded 95% of the time i.e. over the course of a year you would expect to have at least this flow on 346 days.

Figure 11. Example Q95 flow

Q5 is the flow exceeded 5% of the time i.e. over the course of a year you would expect this flow to occur on 18 days.

Q5 is usually equivalent to a full spate.

Figure 12. Example Q5 flow



4.3.1 Why is Q95 important?

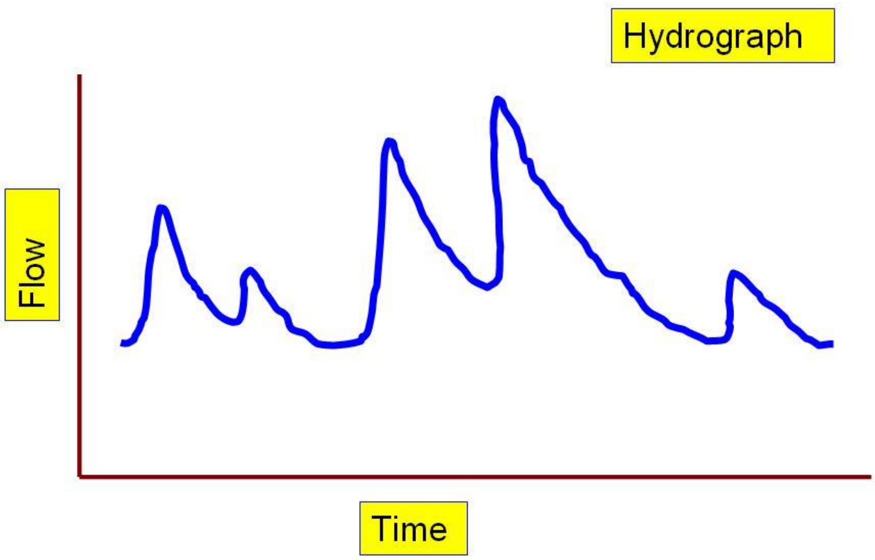
Q95 has been identified as an important flow because below this the river bed is likely to become exposed and damage to the river ecology can occur.

This is why Q95 is often the minimum mitigation flow from impoundments.

4.3.2 How are Flow Exceedences Calculated?

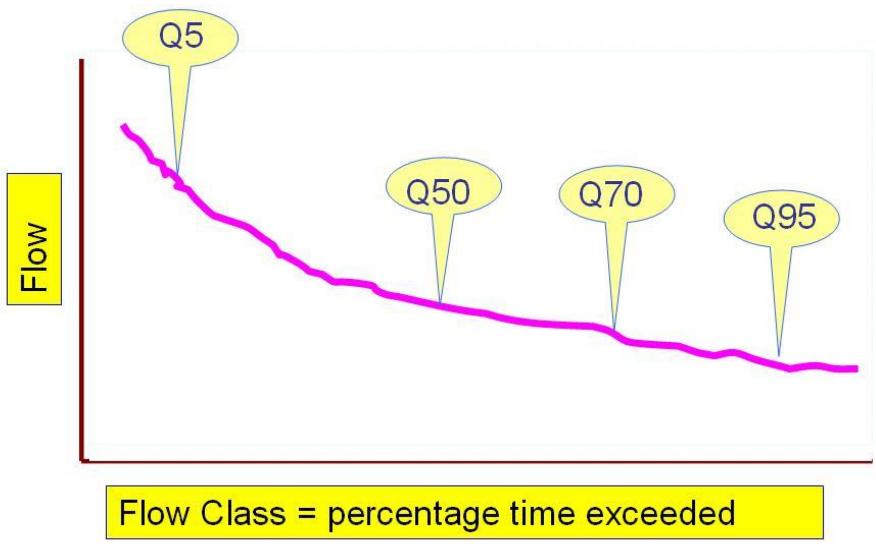
There are two ways of representing changes in river flows. A **hydrograph** simply shows the variation in flow over time (see Figure 13). The graph shows how the average daily flow varies over time.

Figure 13. Hydrograph



The results are displayed graphically in a Flow Duration Curve (FDC) see Figure 14.

Figure 14. Flow Duration Curve



This shows how the range of flows from the hydrograph is distributed over a year. The graph shows how often certain flows are exceeded. As explained previously the higher the flow the smaller percentage of time it is exceeded. Conversely the lower the flow the greater amount of time it is exceeded.

Flow duration curves are used by SEPA when regulating water resources and point source authorisations.

5. Mitigation Flow Checks

5.1 Purpose

- To confirm that the mitigation flows; or hands-off or residual flows, required to be provided by CAR licence conditions are being delivered.
- To confirm that the dimensions and design of the impounding works and/or intake structure, weir and plunge pool are the same as set out in the application for CAR authorisation. This is important as it allows hydraulics calculations to be undertaken to determine whether the structure will meet the mitigation requirements in all flow conditions.
- To ensure that there is no obstruction within the impounding works and/or intake structure, weir and plunge pool preventing or restricting the mitigation flow being delivered, for example sedimentation or debris.
- To confirm that the location of the impounding works and/or intake structure, weir and plunge pool matches with the licensed location.

5.2 Timing of Checks

- The scheme should be generating at the time of the check.
- The percentile flow range for generation can be established using the design minimum and maximum turbine flow and the intake flow duration curve.
- There should be no spill over the intake weir (this ensures that the flow downstream is solely delivered from the mitigation structure).

5.3 Flow Gauging

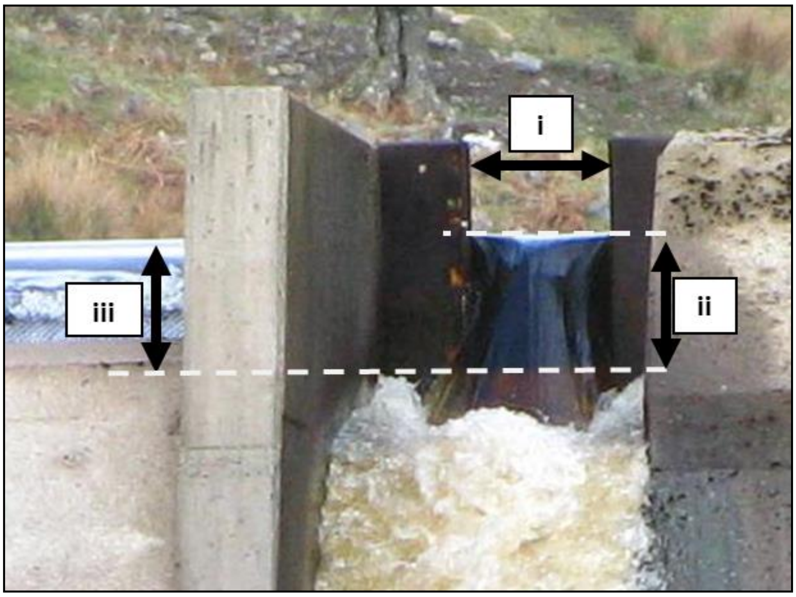
Depending on the expected mitigation flow range the following methods can be used:

- Container and stopwatch (3 separate measurements should be taken and an average used).
- FlowTracker (Acoustic Doppler) / current meter. If a suitable section cannot be identified immediately downstream of the intake allowance must be made for any inter-catchment flow.
- Salt dilution method.

A gauging should be taken upstream of each intake to determine the natural flow conditions on the day, when compared to the agreed flow duration curve. A gauging should also be taken immediately downstream of the impounding works and/or intake structure, weir and plunge pool so the measurement only captures the flow being provided from the structure.

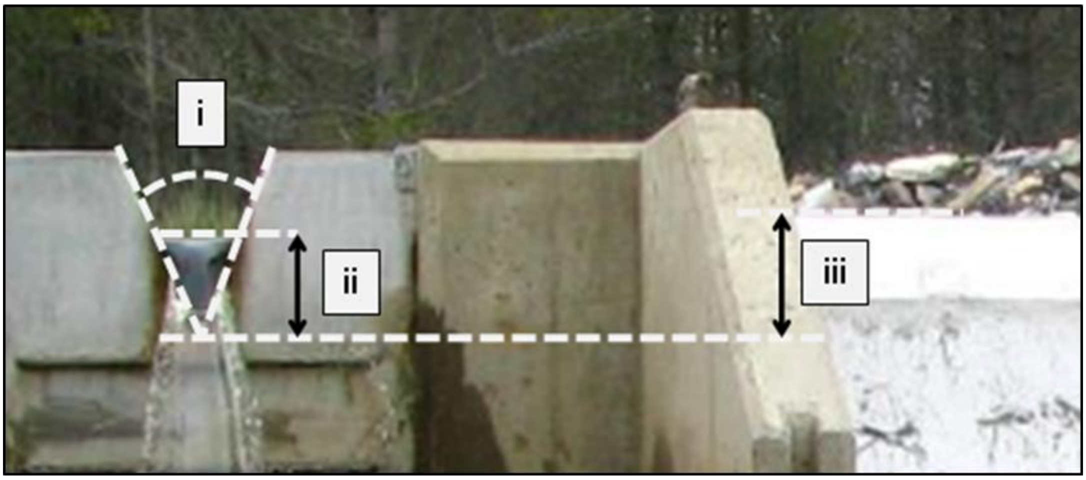
5.4 Measurements Required

Figure 15. Mitigation Structure (rectangular notch)



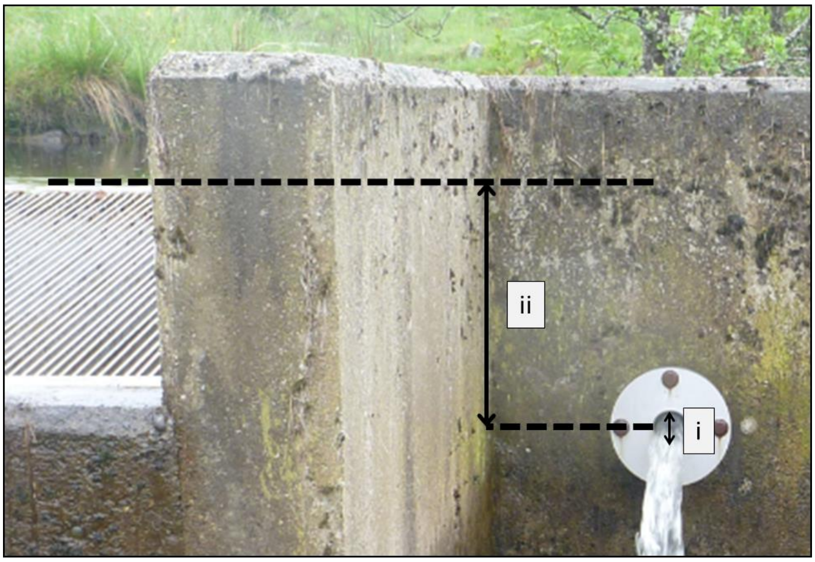
i. Notch width
ii. Height of intake weir crest above notch crest
iii. Height of water level above base of notch
iv. The thickness of the notch plate and how (if at all) the edges are bevelled

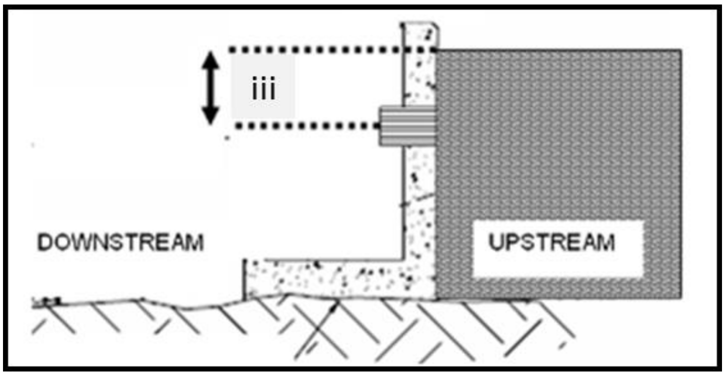
Figure 16. Mitigation Structure (V-notch)



i. Angle of notch
ii. Height of water level above apex of notch
iii. Height of intake weir crest above notch base
iv. The thickness of the notch plate and how (if at all) the edges are bevelled

Figure 17. Mitigation Structure (rectangular notch or V-notch)

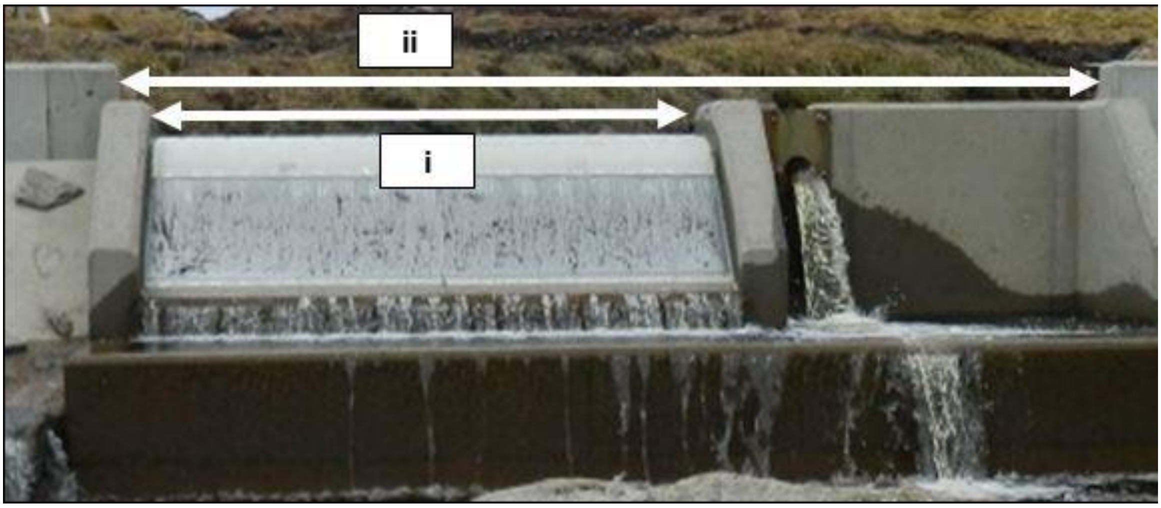




i. Internal diameter of the orifice
ii. Height of intake weir crest above orifice centre point
iii. Water level above centre of the orifice

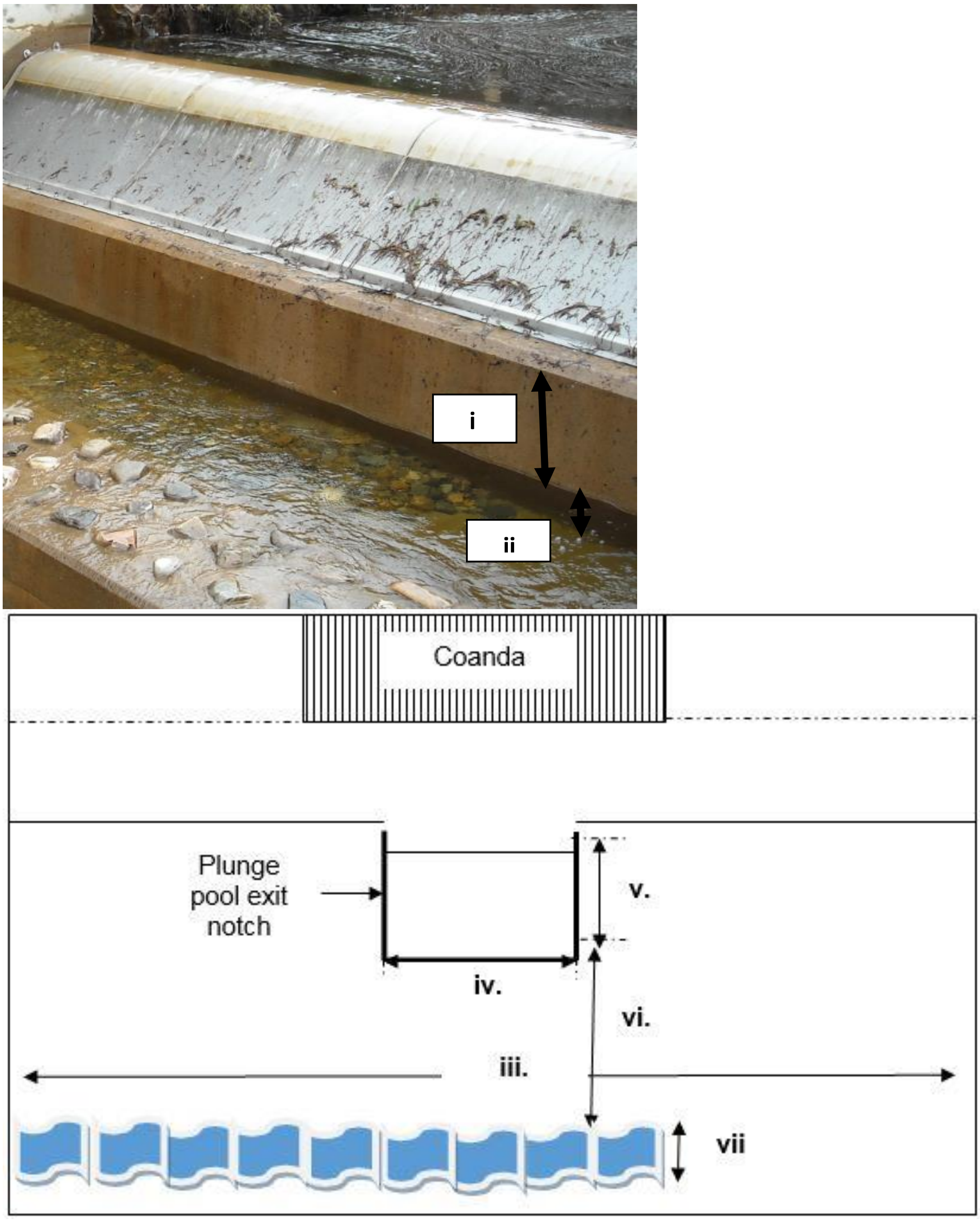
Note: Where a pipe or orifice has been constructed in the wall of the intake chamber, as in the example below, a physical flow measurement will be the only option.

Figure 18. The Intake Weir



i. Width of intake weir
ii. Entire width of approach channel
iii. Breadth of the intake weir crest (direction of flow)

Figure 19. Plunge Pool



i. Height of drop from lip of weir (the base of the screen) to the water surface in the plunge pool;
ii. Depth of plunge pool;
iii. Width of plunge pool (does it cover all areas where water and fish may fall?);
iv. Width of plunge pool exit notch;
v. Depth of water in plunge pool notch;
vi. Height of drop from notch base to water surface below;
vii. Depth of water below notch

5.5 Further information to be recorded and submitted

- Date and time of measurements.
- Whether the intake weir is spilling when checks were carried out.
- Photographs of the impounding works and/or intake structure, weir, plunge pool and screens.
- Photographs of river channel upstream and downstream of the impoundment
- Photograph(s) of the gauging section(s) used to measure flows.
- The extent of any sediment build up behind the weir.
- Photographs of tailrace and upstream and downstream of powerhouse.
- National Grid Reference of the impounding works and/or intake structure.
- As built drawings of the impounding works and/or intake structure weir and associated plunge pools and screens.

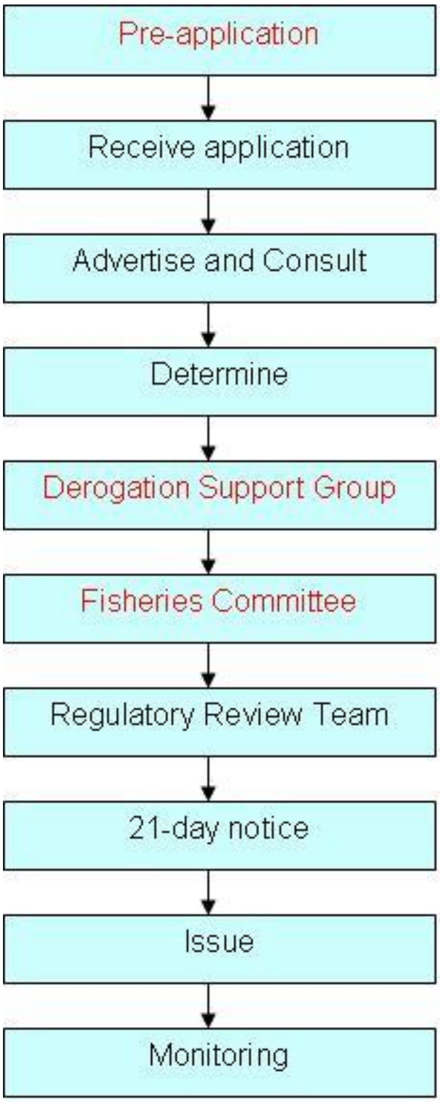
5.6 Submission of information on mitigation

The information required to confirm that the mitigation flows, or hands-off or residual flows, required to be provided by CAR licence conditions are being delivered should be submitted to SEPA in writing. Appendix 1: Mitigation Checklist provides a form that can be used to submit the information. This information must be submitted no more than two months after commencement of the impounding of water or diversion of flows authorised under the licence. Please contact your local SEPA office with any queries relating to the application of this guidance and completion of the checklist.

6. Licence Determination Process

For hydro there are three elements to the licence determination process that should be highlighted:

Figure 20. Licence determination process



6.1 Hydro-specific Elements of Process

6.1.1 Pre-application

SEPA encourages pre-application discussions and where relevant, SEPA should seek joint pre-application discussions with the appropriate external and internal consultees.

SEPA's website contains two useful links to aid discussions on hydro power schemes prior to licence applications being submitted:

- *Guidance for applicants on supporting information requirements for Hydropower applications*

The document provides information on the process for obtaining a water use licence and, in particular, on the minimum information a hydropower developer needs to provide in support of an application for a licence. The document will also highlight where other consents are necessary for a development and how these may interact with the SEPA determination. This document is expected to be extended to include specific details for low head and storage hydropower schemes and

- *Guidance for developers of run-of river hydropower schemes*

The guidance is in two parts:

Part A

- outlines how, in determining applications relating to hydropower schemes, SEPA intends to achieve Scottish Ministers' policy objectives

  "*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 whilst minimising any adverse impacts on the water environment*."

- provides guidance to developers on identifying sub-100 kilowatt hydropower scheme developments that are likely to be acceptable in the context of the Ministers' policy statement.

Part B

- sets out the mitigation SEPA expects to be incorporated into any run-of-river hydropower scheme development.

One of SEPA's pre-authorisation requirements for all hydropower schemes likely to have adverse impacts on the water environment is that all practicable mitigation is taken to limit those impacts. The guidance in Part A on identifying potentially acceptable sub-100 kilowatt schemes applies to proposals that incorporate all practicable mitigation.

6.1.2 Derogation Procedure/Derogation Support Group (DSG)

Due to the abstraction levels and nature of hydropower generation virtually all hydro scheme applications will the derogation procedure to be applied. (However in future, sub-100 kilowatt schemes will not normally need to go through a full derogation process because they will not normally be acceptable if they cause deterioration). The guidance contained within *WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment* should be followed in this instance.

This document provides information for determining the applicability of a derogation for proposals that would:

- Breach an environmental standard
- Cause deterioration of status or

- Prevent the future achievement of an objective in a River Basin Management Plan.

The main roles of the DSG are; supporting operations staff, peer reviewing documents, training and development and review of guidance. Early contact with the DSG is recommended when determining a licence and a single point of contact will be assigned to the officer. The derogation procedure can be complex and normally involves much discussion before concluding on the assessment.

The DSG has a typical turn-around time for reviewing and providing feedback on draft decision documents of 5 working days or less in the majority of cases. This should be done prior to going to the relevant RRT.

The DSG is currently developing an intranet site to highlight the derogation methodology, the group and specific contacts.

The DSG is made up of operations staff (water resources, engineering), hydrology staff, economists and legal staff.

6.1.3 Fisheries (Electricity) Committee

The Fisheries (Electricity) Committee (FC) is expected to be abolished summer 2010. The FC used to be a statutory consultee on applications where SEPA believed that there may be a significant adverse impact on fisheries.

In anticipation of the abolition coming into effect, SEPA has agreed with the Fisheries Committee that we will no longer routinely consult the committee on relevant CAR applications or variations received after 31 May 2010. The committee will continue to give advice to SEPA on schemes where we have already consulted them, until the abolition takes effect. We may also seek advice from the committee on specific issues relating to fish and fisheries until it is formally abolished.

When the abolition takes effect, SEPA fisheries biologists (within ecology) will take up this role in conjunction with relevant external consultees such as local district salmon fisheries boards and SNH.

The Scottish Government asked SEPA to set up a Fish and Fisheries Advisory Group to coordinate advice to SEPA on fish and fisheries. SEPA has now formed this group however the group does not comment on individual licence applications.

6.2 Internal Consultees

Internal consultation is required on all hydropower licence applications. The list below contains the remit of all internal consultees and when they should be consulted on a hydropower licence application. This may be for every application or only if there is a site specific issue. A copy of the relevant parts of the licence application should be forwarded if appropriate.

For information on the external consultees regarding their requirements and remits are included in the *Guidance for applicants on supporting information requirements for Hydropower applications*.

Table 2. List of Internal Consultees

Hydrology **- Consult for all hydro applications**
How to contact Hydrology: Requests for hydrology information or comments should always be emailed to *Hydro Enquiries*.
Pre Application advice: It is very important that hydrology is involved as soon as possible with any proposed schemes. Discussions at the pre-application stage can clarify the hydrology data required, acceptable methods of gathering this data and techniques for analysing the data. Clarification at this early stage can save a lot of time and complications post-application. Hydrology is often contacted directly by developers for pre-application enquiries.
Information Hydrology provide: For any pre or post-application enquiry SEPA Hydrology will provide a formal report on the proposed scheme detailing the hydrological impact and any additional comments relevant to the determination process: • Flow Data – confirmation of the acceptability of flow data provided and analysis carried out. • Environmental Standards – Hydrology provides an assessment of the risk to the ecological quality of the water environment as a result of flow changes. It does this by applying the relevant environmental standards for river flows and loch levels. • Design of Intake – audit of design and calculations to confirm that the required mitigation flows will be delivered. Note: as the required mitigation flows may only be determined following the consultation process this stage may occur late in the determination process or in some cases post licence issue but prior to construction. • Mitigation flow audit – hydrology can provide support in confirming that the required mitigation flows are being provided from intakes post construction.
DSG- Consult for all hydro applications
Provide comments guidance on the *WAT-RM-34* methodology on assessing applications likely to result in significant adverse impacts on the water environment. Peer review draft decision documents. See section 6.1.2above.
Water Resource Specialists- Consult if site specific issue
Provide comments and guidance on the licence application throughout all parts of the determination process if required.

Ecology- Consult if site specific issue
Provide comments and guidance on ecological aspects of the licence application including sites where there is a relevant natural heritage designation. This is usually in relation to supporting information that has been supplied with the application but may also include pre-application discussions, mitigation, monitoring plans and any consultation with SNH and Local fisheries boards. Where there is a particular risk to fish populations or sediment management then a fish biologist or geomorphologist respectively may be required.
Engineering Specialists- Consult if site specific issue
Provide comments and guidance on engineering aspects of any hydropower scheme. This is usually in relation to the impact of impoundments or proposed construction works.

6.3 Templates and Bank of Conditions

WAT-TEMP-78: Run of River Hydro Power Licence Template is the most commonly used. There is currently no template for storage schemes so if you are dealing with an application for a storage scheme contact should be made with your local water resources specialist. The run-of-river template would form the basis of the storage scheme licence and relevant storage related conditions would be incorporated from the bank of conditions.

The run-of-river template has tried to incorporate all relevant conditions so it is unlikely that there will be a need to utilise the bank of conditions. However it should be highlighted that any conditions from the Water Resources abstraction and impoundment bank of conditions (*WAT-TEMP-14* & *WAT-TEMP-16*) can be considered for a run-of river licence. It is possible that site specific issues could generate the requirement for bespoke conditions. If bespoke conditions are needed then legal input should be sought and the condition agreed before referral to the relevant Regulatory Review Team.

6.4 CLAS

At the moment CLAS only records certain data for hydro schemes as mandatory e.g. abstraction rates and volumes, source types and measurement types. There is the ability to include much more information such as compensation flows, returns, freshets, hands off flows, fish passes, screens and derogation details.

There are implications for not entering such data in CLAS. The system is linked to the Low Flows 2000 model used by hydrology. Where hydrological modelling cannot be carried out which reasonably accurately reflects the situation on the ground it compromises SEPA ability to classify water bodies for water resource impacts and affects the assessment of new application. This can impact on point source where the absence of a compensation flow will alter the dilution available, and for downstream abstractors it would limit the apparent flow available where for example no return has been inputted into CLAS.

There will also be charging implications if inaccurate data is entered or no data is entered as CLAS is linked directly to charging including the raising of subsistence invoices.

7. Monitoring

7.1 Standard Monitoring Requirements & Associated Documents

A run-of-river licence will have several standard monitoring requirements and associated plans/drawings/statements:

Standard monitoring and information required	Submission of associated plans for SEPA approval	Reporting and Ongoing monitoring
Monitoring plan (for abstraction and impoundment)	Prior to commencement of activity	Inspections and Data returns annually by 31 Jan
Design drawings for intake and return structures	2 months prior to commencement of construction of structure	Completion inspection only. No reporting required.
Construction method statement for associated works	1 month prior to commencement of construction of structure	Inspection only (complex licences). No reporting required.

There are tracking issues once the licence has been issued. As can be seen above there are various plans to be submitted to SEPA for approval plus relevant reporting requirements and periodic data returns. This has implications for assessing compliance with licence conditions.

7.2 Assessment of Documents (Standard Plans, Drawings & Statements)

7.2.1 Monitoring plans

Prior to commencement of any of the authorised activities the above plans/drawings and statements are requested by SEPA.

The plans should include monitoring locations, equipment, methods and data recording procedures to be used to demonstrate compliance with licence conditions.

General guidance is included in *WAT-SG-51: Water Resource Licence Monitoring Plan Guidance.* A monitoring plan template is available in *WAT-TEMP-68: Water Resource Monitoring Plan Licence Template*. Internal consultees may also input to the plan prior to approval.

7.2.2 Design drawings for Intake and Outfall Structures

General guidance is available in *WAT-SG-28: Good Practice Guide - Intakes & Outfalls* and *WAT-SG-54: Technical Guide to Flow Measurement* however hydrology should be consulted prior to SEPA approval.

7.2.3 Construction method statements

Guidance is available in *WAT-SG-29: Good Practice Guide - Construction Methods*.

7.3 Site-specific Monitoring Requirements

7.3.1 When is site specific monitoring required?

SEPA should only request site specific post construction monitoring when the results gathered from any monitoring could be used to vary a licence condition and amend mitigation measures, such as compensation flows. Monitoring will only be requested at certain sites based on ecological sensitivities. An example of this is radio tracking survey work on migratory fish to establish behaviour patterns under different flow conditions. Fisheries biologists should be consulted on this aspect.

If SEPA intend to vary licence conditions based on the results of the monitoring, then there also should have been monitoring undertaken prior to the licence application to enable a base level of information to be gathered and therefore compare against.

The type and level of monitoring that will be undertaken during pre-application will have been guided by SEPA's document *Guidance for applicants on supporting information requirements for Hydropower applications*. There will also be instances when additional monitoring is requested as an outcome of undertaking the consultation and advertising process.

Co-ordinating officers should consult the relevant internal consultees such as fisheries biologists, hydrology, geomorphologists and water resource specialists prior to finalising any site specific monitoring.

7.3.2 Site specific monitoring requirements could include:

Site specific monitoring information required	Submission of associated plans for SEPA approval	Reporting and Ongoing monitoring examples
Fish monitoring plan (quantitative, qualitative, radio tracking surveys)	Within 3 months of date of issue of licence	Data returns every 2 years by 31 Jan
Sediment management plans	Within 6 months of date of issue of licence	Possible data returns for volume of sediment removed

7.4 Assessment of Site-specific plans

7.4.1 Fish Monitoring plans

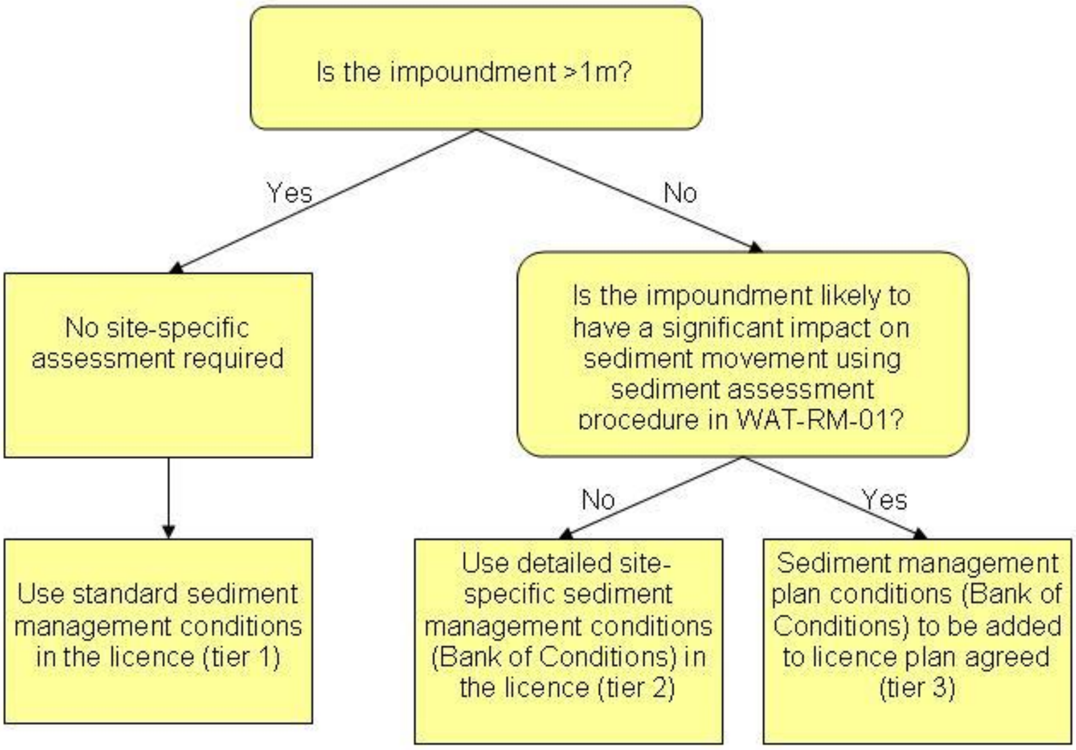
Information on types of fish survey is included in the *Guidance for applicants on supporting information requirements for Hydropower applications*.

Fisheries biologists must be consulted before finalising any plans.

7.4.2 Sediment management plans

There is a tiered approach to the requirement for sediment management plans.

Figure 21. Requirement for sediment management plan



WAT-SG-26: Good Practice Guide - Sediment Management provides background information that will help when assessing plans. If necessary a geomorphologist should be consulted.

8. Frequently Asked Questions

Do hydro schemes qualify for Environment Service through the charging scheme?

No. Hydro schemes are producing green energy but abstract large volumes of water and usually have significant impoundments. More often than not they are also commercial operations. They therefore do not qualify.

For schemes <100kW do SEPA require application fees for both the impoundment and abstraction?

No. A single simple licence fee is required and this covers all activities. There will also be no associated subsistence fee. See the *Water Environment (Controlled Activities) Charging Scheme*.

Does the charging scheme offer application fee reductions for associated activities on large hydro schemes?

Yes – reductions in fees apply for second and subsequent associated activities at hydro schemes. See the *Water Environment (Controlled Activities) Charging Scheme*.

Can SEPA give out flow estimates to potential applicants?

No. SEPA are unable to provide flow estimates due to licensing restrictions with Low Flows 2000. Applicants must source their own flow estimates or measurements where required. SEPA will only analyse what has been submitted.

Do very small schemes (<10kW) need to be advertised?

There will be some circumstances where scheme in its entirety is within applicants land ownership and there are obviously no downstream third party interests, where it may be possible to waive advertising. See *WAT-RM-20: Advertising and Consultation*.

9. Glossary

Glossary of terms commonly used within hydro sector

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	A condition when the flow in the river falls below a specified level abstraction has to cease (or reduce).
Installed Capacity	The total maximum output (kw) of the turbine/s.
Load Factor	The ratio of energy generated in comparison to the potential generation if the scheme runs at full capacity for the whole year.
Kilowatt (kW)	A unit of power, equal to 1000 watts.
Megawatt (MW)	A unit of power, equal to 1000 kilowatts.
Gigawatt (GW)	A unit of power, equal to 1000 megawatts
Penstock	A pipe that conveys water from the intakes to the powerhouse.
Residual flow	The remaining flow left downstream of an intake when abstraction takes place. Usually variable and above Hands off flow as levels change.
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.
Tailrace	The pipe/ channel that delivers water back to the environment after being passed through the turbine.
Freshet	A volume of water that is released from storage reservoirs/lochs at a higher rate than compensation flow to mimic higher flow conditions. They generally last for at least 24 hours. They are primarily for fish and ecology purposes.

Appendix 1: Mitigation Checklist

Mitigation checks at <<Enter hydropower facility name>> subject to licence reference CAR/<<Enter reference number>>

You can use this form to submit your

Measurement and observation made:	<<Enter time>>	<<Enter date>>	
Structures checked:	<<Enter name>>	<<Enter NGR>>	<<Enter As-built drawing ref>>
	<<Enter name>>	<<Enter NGR>>	<<Enter As-built drawing ref>>
	<<Enter name>>	<<Enter NGR>>	<<Enter As-built drawing ref>>
	<<Enter name>>	<<Enter NGR>>	<<Enter As-built drawing ref>>
	<<Enter name>>	<<Enter NGR>>	<<Enter As-built drawing ref>>
Operational state	<<Enter Description of the operational state of the scheme during the period when measurements and observations were made e.g. whether intake weir spilling, rate of abstraction etc.>>		
Measurements: Rectangular Notch			
Structure name		<<Enter data>>	
Notch width		<<Enter data>>	
Height oif intake weir crest above notch crest		<<Enter data>>	
Height of water level above base of notch		<<Enter data>>	
The thickness of the notch plate and how (if at all) the edges are bevelled		<<Enter data>>	
Measurements: V-Notch			
Structure name		<<Enter data>>	
Angle of notch		<<Enter data>>	
Height of water level above apex of notch		<<Enter data>>	
Height of intake weir crest above notch base		<<Enter data>>	
The thickness of the notch plate and how (if at all) the edges are bevelled		<<Enter data>>	
Rectangular Notch or V-Notch			
Structure name		<<Enter data>>	
Internal diameter of the orifice		<<Enter data>>	
Height of intake weir crest above orifice centre		<<Enter data>>	

point	
Water level above centre of the orifice	<<Enter data>>
Intake Weir	
Structure name	<<Enter data>>
Internal diameter of the orifice	<<Enter data>>
Width of intake weir	<<Enter data>>
Entire width of approach channel	<<Enter data>>
Breadth of the intake weir crest (direction of flow)	<<Enter data>>
Plunge Pool	
Structure name	<<Enter data>>
Height of drop from lip of weir (the base of the screen) to the water surface in the plunge pool	<<Enter data>>
Depth of plunge pool;	<<Enter data>>
Width of plunge pool (does it cover all areas where water and fish may fall?);	<<Enter data>>
Width of plunge pool exit notch;	<<Enter data>>
Depth of water in plunge pool notch;	<<Enter data>>
Height of drop from notch base to water surface below;	<<Enter data>>
Depth of water below notch.	<<Enter data>>
Photograph references	
Structure name	<<Enter data>>
The impounding works and/or intake structure, weir, plunge pool and screens	<<Enter data>>
The river channel upstream and downstream of the impoundment	<<Enter data>>
The gauging section(s) used to measure flows	<<Enter data>>
The tailrace and upstream and downstream of powerhouse	<<Enter data>>
The extent of any sediment build up behind the weir	<<Enter data>>

References

NOTE: Linked references to other documents have been disabled in this web version of the document.

See the Water >Guidance pages of the SEPA website for Guidance and other documentation (*www.sepa.org.uk/regulations/water/guidance/*).

All references to external documents are listed on this page along with an indicative URL to help locate the document. The full path is not provided as SEPA can not guarantee its future location.

Key References

WAT-RM-01: Regulation of Abstractions and Impoundments

WAT-RM-20: Advertising and Consultation

WAT-RM-34: Derogation Determination - Adverse Impacts on the Water Environment

WAT-SG-26: Good Practice Guide - Sediment Management

WAT-SG-28: Good Practice Guide - Intakes & Outfalls

WAT-SG-29: Good Practice Guide - Construction Methods

WAT-SG-51: Water Resource Licence Monitoring Plan Guidance

WAT-SG-54: Technical Guide to Flow Measurement

WAT-TEMP-14: Bank of Conditions Water Resources (Abstraction)

WAT-TEMP-16: Bank of Conditions Water Resources (Impoundments)

WAT-TEMP-68: Water Resource Monitoring Plan Licence Template

WAT-TEMP-78: Run of River Hydro Power Licence Template

Secondary Documents

A Guide to UK Mini Hydro Developments BHA (www.british-hydro.org)

Consultation on a proposed Memorandum of Understanding (MoU) with the Fisheries (Electricity) Committee Closed Jan 2008 (www.sepa.org.uk)

Controlled Activities Regulations: Guidance for applicants on supporting information requirements for Hydropower applications (www.sepa.org.uk)

Guidance for developers of run-of river hydropower schemes (www.sepa.org.uk)

Water Environment (Controlled Activities) Charging Scheme (www.sepa.org.uk)

- End of Document -