

Engineering in the Water Environment
Good Practice Guide

Temporary Construction Methods



First edition, March 2009

Your comments

SEPA is committed to ensuring its Good Practice

Guides are useful and relevant to those carrying out activities in Scotland's water environment.

We welcome your comments on this Good Practice Guide so that we can improve future editions.

A feedback form and details on how to send your comments to us can be found at the back of this guide in Appendix 1.

Engineering in the Water Environment Good Practice Guide:
Temporary Construction Methods
First edition, March 2009
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1 Introduction

This document is one of a series of good practice guides produced by SEPA to help people involved in the selection of sustainable engineering solutions that minimise harm to the water environment. This Guide is intended for use by those considering engineering activities in rivers or lochs and SEPA staff.

SEPA expects all new engineering activities authorised under the Water Environment Water Environment (Controlled Activities) (Scotland) Regulations 2011 (“CAR”).– also known as the Controlled Activities Regulations or CAR– to follow good practice. Good practice is defined as the course of action that serves a demonstrated need and is sustainable (ie the work is justified and the chosen design is effective), while minimising ecological harm and at a cost that is not disproportionately high.

Applicants proposing to undertake an engineering activity will be expected to demonstrate to SEPA that good practice has been adopted (see box below). Part of this involves ensuring that harm to the environment is minimised during the construction phase (question 5 below).

This Guide is designed to help applicants:

- ensure good practice is carried out during the construction phase for all engineering activities in the water environment;
- help provide the information required in the CAR application form.

Summary of SEPA good practice tests

1. Have you demonstrated a need for the proposed activity?
2. Have you considered appropriate alternative approaches?
3. Does the proposal represent the best environmental option?
4. Is the activity designed appropriately?
5. **Have all necessary steps been taken to minimise the risk of pollution and damage to habitat or flora/fauna during construction?**

This document is not intended as a technical design manual. It is important to recognise that any engineering works must be designed to suit site-specific conditions. This document addresses the environmental aspects that should be considered when undertaking a project.

Under the Controlled Activities Regulations new engineering activities in Scotland's rivers, lochs and wetlands require an authorisation from SEPA. More information is available in the CAR Practical Guide <http://www.sepa.org.uk/regulations/water/>

Oil must be stored in accordance with the Water Environment (Oil Storage) (Scotland) Regulations 2006. The Regulations apply to any kind of oil including petrol, diesel, mineral oil, heating oil, lubricating oil, waste oil, vegetable and plant oil. More information on these regulations and when they apply can be found on the SEPA website <http://www.sepa.org.uk/regulations/water/pollution-control/scottish-oil-storage-regulations/>

1.1 What's included in this Guide?

This Guide focuses on temporary construction works required when working in rivers or lochs. It does not cover pollution prevention measures for the wider construction site. There is already considerable guidance (see box below) on preventing pollution from construction sites, which should be considered along with the guidance given in this Guide.

The good practice guidance given in Section 3 of this Guide covers the following tasks:

- planning and site set-up;
- site clearance;
- minimising run-off;
- isolation of works area;
- de-watering of isolated area;
- treatment/disposal of contaminated water;
- temporary river crossings;
- reinstatement of bed/banks.

Colour coded boxes in this guide highlight key information.

Green boxes provide summaries of important points.

Blue boxes provide details of other useful sources of information.

Orange boxes provide summaries of regulatory information.

Guidance on preventing pollution from construction sites

CIRIA publications – available from <https://www.ciria.org/>

- *Control of Water Pollution from Construction Sites – Guide to Good Practice (SP156)*
- *Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532)*
- *Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648)*
- *Control of Water Pollution from Linear Construction Projects – Site Guide (C649)*
- *Environmental Good Practice – Site Guide (C650)*
- *The SUDS Manual (C697)*
- *Site Handbook for the Construction of SUDS (C698)*

Pollution prevention guidance published jointly by Environment Agency, SEPA and Environment and Heritage Service:

- *Getting Your Site Right. Industrial and Commercial Pollution Prevention.*
www.environment-agency.gov.uk/static/documents/Business/pp_pays_booklet_e_1212832.pdf
- *Pollution Prevention Guideline (PPG) 5: Works and Maintenance In or Near Water*
- *Pollution Prevention Guideline (PPG) 6: Working at Construction and Demolition Sites*
- *Pollution Prevention Guideline (PPG) 21: Pollution Incident Response Planning*
- *Pollution Prevention Guideline (PPG) 18: Managing Fire Water and Major Spillages*

2 Impact of the construction phase on the water environment

Although the construction phase of any project is short term compared with the permanent works that are being built, the risk of pollution and damage to the water environment during this phase is very high. These risks are summarised below.

2.1 Pollution

Scotland generally experiences the highest annual rainfall in the UK. But within Scotland rainfall can vary considerably; in parts of the West Highlands annual rainfall can be up to 3m compared to less than 800mm in parts of the east coast. This is an important consideration for construction works in Scotland, as rainfall increases the risks of pollution and damage to the water environment also increase.

Rainfall and associated surface water run-off during construction works can mobilise and transport pollutants such as sediment, oils, chemicals and other building materials into the water environment causing harm to plants and animals. Heavy rainfall can also flood excavations and other work areas which subsequently require draining or de-watering. When working in or near rivers, construction sites are more at risk of flooding from rising river levels.

Pollution from sediment and other pollutants can come from a number of sources on construction sites (see box below).

Potential sources of pollution on construction sites

- Direct disturbance of the banks and bed of rivers and lochs
- De-watering of excavations
- Run-off from exposed ground and material stockpiles
- Run-off from roads and haul routes and river crossings
- Plant washings/washing areas
- Fuel and chemical storage/refuelling areas
- Leaking/vandalised equipment

Impacts of pollution can include the following.

- Sediment pollution can smother important river habitats such as fish spawning habitats (see Figure 1).
- Pollution from fuels and other chemicals can have a variety of effects on fresh water ecology and can lead to fish and invertebrates being killed in lochs and along long lengths of river.
- Cement pollution of waters results in high alkalinity and raises the pH, which can be toxic to aquatic life.
- Even very small amounts of material can be a pollutant. For example, five litres of oil can disperse to cover an area of water the size of four football pitches.

- All these forms of pollution can also render receiving waters unsuitable for potable or industrial abstraction, fish farming, angling, agricultural stock watering, and general amenity/tourism.

Figure 1 *X* Poor practice on a construction site leading to polluted surface water run-off



2.2 Damage to habitats

Important habitats, including protected habitats and species, can be lost during the construction phase both through direct loss during site clearance (see Figure 2) or indirectly due to loss through pollution and/or disruption. For example, if a temporary crossing is a barrier to fish passage at key migratory times, fish will be prevented from reaching upstream spawning grounds. Otter holts/water vole colonies/salmonid and lamprey spawning areas could be destroyed. There is also the risk of spreading invasive non-native plants such as Japanese knotweed during construction. In the worst cases, long-term or even permanent damage may occur.

Figure 2 Habitats such as sand martin burrows can be destroyed during the construction phase



3 Good practice guidance

3.1 Planning and site set-up

Most pollution incidents are avoidable and the risk of pollution and damage to the water environment can be reduced by careful planning.

Planning stage considerations:

- Identify the location of all watercourses, lochs, wetlands and drainage paths for surface water.
- Identify protected habitats and species.
- Assess potential flood risks.
- Identify potential sources of pollution (see Section 2).
- Timing of works.
- Space should be put aside for Sustainable Urban Drainage Systems (SUDS) or SUDS equivalent.
- Train staff.
- Emergency procedures.
- Monitoring requirements.

The risk of pollution and damage to the water environment should be minimised by careful planning. The following should be considered at the planning stage.

Location of surface waters

Identify the location of all rivers, lochs, wetlands, burns, ditches, drains and drainage paths for surface water and how the proposed works will affect them by undertaking an appropriate pre-works survey (desk-based and on-site verification). Buffer strips and working/storage distances from watercourses should be considered.

Protected habitats / species

Identify key habitats and designated areas on or adjacent to the site, eg Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs), RAMSAR sites.

Flood risk

Assess potential flood risks to the site during the works. Check the SEPA Indicative River & Coastal Flood Map (<http://www.sepa.org.uk/environment/water/flooding/flood-maps/>) for an indication of the extent of site likely to be affected by flooding.

Sources of pollution

Identify potential sources of pollution (see Section 2). Also consider methods of disposing of contaminated water.

Timing

Plan the timing of work to avoid sensitive times of the year, eg fish spawning, fish migration time and bird nesting season.

Space for SUDS

Put aside adequate space for SUDS including facilities such as settlement ponds during construction stages of a project. Where the construction will lead to a permanent facility requiring surface water drainage, consider how systems deployed to treat run-off during construction might be retained or converted into permanent SUDS to serve the built structure once completed.

Train staff

All personnel from the site manager to engineers, foremen, plant operatives, sub-contractors, tradesmen and labourers have a part to play in preventing pollution and harm to the water environment during construction. It is crucial that each member of the site staff is aware of the potential impact of their activities and is equipped with the knowledge of how to eliminate or reduce that impact. Lack of training and awareness of environmental impact can often result in bad practices unwittingly being adopted. Bad practices can in turn lead to pollution or degradation of adjacent rivers, lochs and wetlands.

Emergency procedures

At the project planning stage it is essential to think through the possible incidents and emergencies which could arise during construction works and plan accordingly (risk assessments). These may include:

- pollution incidents – spillages, failure of temporary works, bank collapse, vandalism, fire, etc;
- extreme weather events – heavy rainfall, flooding, severe frost and snow.

Put in place an emergency response plan on site with a procedure for dealing with emergencies and communicate this procedure to all site staff at site induction.

Site staff responsible for taking action in emergencies must be:

- aware of their responsibilities;
- trained to use the necessary equipment such as spill control equipment and shut-off valves.

For further guidance, refer to the following Pollution Prevention Guidelines (PPGs) (www.environment-agency.gov.uk/netregs/links/63893.aspx):

- PPG 21: *Pollution Incident Response Planning*;
- PPG 18: *Managing Fire Water and Major Spillages*.

PPG21 includes an example of a typical pollution incident response plan which could be amended to suit different site situations.

Variations

No matter how well planned a construction project, variations to the permanent works, temporary works, programme or work methods are often necessary. If not carefully considered even minor variations can have a significant impact on the water environment. It is therefore vital that the need for a variation is communicated clearly from the site to the person with overall responsibility for environmental matters. Allow this person sufficient time

to assess the risks to the water environment and to consult with the designer before any variation is implemented.

For substantial or significant variations, it may be necessary to consult SEPA or submit revised details construction and method statements for approval. If there is any doubt about the impact of a variation, SEPA should be consulted.

Monitoring requirements

Monitoring can help determine if construction works are having an impact on the water environment. This can help assess the effectiveness of pollution prevention measures and give early warning of pollution incidents so that corrective action can be taken.

Sources of further information on good practice in planning and site set up

CIRIA publications – available from <https://www.ciria.org/>

- *Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532)*
- *Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648)*
- *Control of Water Pollution from Linear Construction Projects – Site Guide (C649)*
- *Environmental Good Practice – Site Guide (C650)*
- *The SUDS Manual (C697)*
- *Site Handbook for the Construction of SUDS (C698)*

Pollution prevention guidance published jointly by Environment Agency, SEPA and Environment and Heritage Service:

- *Getting Your Site Right. Industrial and Commercial Pollution Prevention.*
www.environment-agency.gov.uk/static/documents/Business/pp_pays_booklet_e_1212832.pdf
- PPG5: *Works and Maintenance In or Near Water*
- PPG6: *Working at Construction and Demolition Sites*
- PPG18: *Managing Fire Water and Major Spillages*
- PPG21: *Pollution Incident Response Planning*

PPGs are available from the NetRegs website (www.environment-agency.gov.uk/netregs/links/63893.aspx).

3.2 Site clearance

During site clearance (vegetation removal and demolition operations) rivers, lochs and wetlands are particularly vulnerable to loss of wildlife habitats and pollution (see Figure 3).

Figure 3 Tree clearing prior to river engineering works



Avoid unnecessary vegetation clearance. This keeps damage to a minimum and helps prevent sediment pollution from run-off. Only clear vegetation when works are required; adopt a phased approach to avoid clearing the whole site at once, leaving exposed ground for long periods of time.

Establish buffer zones around watercourses and protected habitats/species. Do not disturb protected habitats/species and establish exclusion zones that are suitably isolated from works using fences, barriers, screens and signage (seek guidance from Scottish Natural Heritage). Contact the local authority planning department to identify any trees subject to a Tree Preservation Order.

Remove invasive or noxious plants (Japanese knotweed, Giant hogweed, ragwort and Himalayan balsam) before works commence. It is an offence to plant or cause any non-native plant species to grow in the wild in Scotland. See the sources of further information given at the end of this section for:

- details of removal methods and any associated authorisations required;
- requirements for transfer of the resulting controlled waste.

The timing of vegetation removal should be considered carefully to avoid particularly sensitive periods of the year (eg bird nesting season). Refer to Scottish Natural Heritage for advice.

Do not dispose of removed vegetation in watercourses and prevent debris from vegetation removal operations from falling into the water. This can be done by removing vegetation from behind the bank and pulling it away from the water, or by placing screens or nets between the vegetation and the water. Where this is impractical, use booms or temporary screens to

collect any floating debris so that it can then be easily removed. This type of recovery should cause as little disruption to the watercourse as possible.

Vegetation removal is likely to destabilise the banks and/or bed of the watercourse or make them more vulnerable to erosion (see Figure 4). Removal of vegetation can also alter flow patterns and induce or accelerate bank or bed erosion. It is vital to take measures to ensure the stability of the bank, particularly where there is a risk of raised water levels (high flows) until the vegetation is re-established. Biodegradable textiles can be used to protect areas of bare soil; for more information see Section 3.8 and SEPA Good Practice Guide WAT-SG-23, Bank Protection: Rivers and Lochs

[\(http://www.sepa.org.uk/regulations/water/engineering/engineering-guidance/\)](http://www.sepa.org.uk/regulations/water/engineering/engineering-guidance/).

Figure 4 X Poor practice: vegetation cleared and bare soil exposed to allow construction of floodwall leaving risk of bank erosion during a high flow event and rainfall run-off causing silt/sediment pollution



Sources of further information on good practice in site clearance

SEPA publications: <http://www.sepa.org.uk/regulations/water/engineering/engineering-guidance>

- *Riparian Vegetation Management* (WAT-SG-44).
- *Bank Protection: Rivers and Lochs* (WAT-SG-23).
- *On-site Management of Japanese Knotweed and Associated Contaminated Soils*, Technical Guidance Note, Version http://www.sepa.org.uk/media/154142/onsite_mangaement_of_japanese_knotweed_associated_soils.pdf

Other publications:

- *Guidance for the Control of Non-native Invasive Weeds In or Near Fresh Water*, Environment Agency, 2007. <http://publications.environment-agency.gov.uk/pdf/GEHO0307BLZO-e-e.pdf>
- Environment Agency facts sheets on invasive species: www.environment-agency.gov.uk/homeandleisure/wildlife/31350.aspx
- *BS 5837: 2005 Trees in Relation to Construction – Recommendations*. www.bsi-global.com

3.3 Minimise run-off of contaminated water

As stated in Section 1, this Guide focuses on temporary works required for the construction of engineering activities in river or lochs. It does not cover pollution prevention measures for the whole construction site. This section describes some basic principles but does not go into detail on preventing pollution from the wider construction site as there is already considerable existing guidance on this subject which should be followed (see box below).

As discussed in Section 2, contaminated water can arise from a number of sources including:

- direct disturbance of the river bed or bank;
- de-watering of excavations;
- run-off from exposed ground and material stockpiles (see Figure 5);
- run-off from roads and haul routes and river crossings;
- plant washings;
- fuel and chemical storage/refuelling areas;
- leaking/vandalised equipment.

The risk of water becoming polluted in the first place should be minimised. All sources of pollution should be identified at the planning stage (see Section 3.1) and appropriate mitigation measures put in place.

Figure 5 X Poor practice: topsoil from excavations stockpiled beside river leaving risk of pollution from run-off or high flow



Locate areas of high risk away from watercourses and drainage paths. Areas of high risk include:

- fuel and chemical storage;
- refuelling areas;
- material stockpiles;
- vehicle and equipment washing areas;
- site compounds/parking areas.

Store fuel, oils and chemicals on an impervious base within a bund able to contain at least 110% of the volume stored.

If possible use biodegradable oil in plant and machinery. Biodegradable oil is less toxic than most synthetic oil but should still be used and stored to the same standards as other oils.

Oil must be stored in accordance with the Water Environment (Oil Storage) (Scotland) Regulations 2006. The Regulations apply to any kind of oil including petrol, diesel, mineral oil, heating oil, lubricating oil, waste oil, vegetable and plant oil. More information on these regulations and when they apply can be found on the SEPA website (<http://www.sepa.org.uk/regulations/water/pollution-control/scottish-oil-storage-regulations/>)

There are three simple principles which should be followed to minimise the volume of contaminated run-off being generated.

- **DIVERT** clean water away from exposed soils and working areas.
- **MINIMISE** erosion of exposed soils.
- **PREVENT** contaminated water from entering watercourses untreated.

The selection of control measures will depend on how effective they will be on a site-by-site basis. The effectiveness of control measures will depend on weather, site characteristics and construction activities. It is important that the selected control measures are inspected regularly – and particularly after rainfall – to assess:

- effectiveness;
- the need for maintenance or replacement with alternative measures.

DIVERT clean surface water away from exposed soils

This can significantly reduce the volume of water contaminated with sediment on site thus reducing the risk of pollution and the costs associated with treating contaminated water before discharge.

- **Diversion drains.** Such diversion can be implemented on the upstream perimeter of the site or immediately upstream of areas of exposed soil on the site (eg excavations, embankments and stockpiles). Line drains with a non-erodible material such as turf/geotextiles.
- **Bunds.** These can be placed around exposed soils such as excavations/material stockpiles. This will prevent clean water entering the area and dirty water from leaving the area. Bunds should be made of non-erodible material such as straw bales/geotextiles.

Route uncontaminated water to nearby land or surface water.

MINIMISE erosion of exposed soils

The most obvious way to minimise erosion is to minimise the amount of soil exposed. Existing mature vegetation will not only be able to absorb rainfall and filter sediment polluted run-off, but the extensive root systems help to hold soils together and reduce erosion.

Leave as much existing vegetation in place as possible and protect it with fences and signs where necessary. Only clear that part of the site which will be worked on in the near future. Consider phasing site clearance for different stages of the work.

Leave buffer strips of vegetation 5–10m wide along site boundaries and river banks to act as sediment filters. Buffer strips are generally secondary measures and must not be used as the sole method to prevent or treat the escape of polluted water.

Where it is necessary to remove vegetation and it will not to be replaced by permanent works, establish new/replacement vegetation (using seeds from a local and reputable source) as soon as practicable. Until vegetation is fully re-established, temporary protection of the soil may be necessary (see below). For further guidance on establishing vegetation

see SEPA Good Practice Guide WAT-SG-44, *Riparian Vegetation Management* (<http://www.sepa.org.uk/regulations/water/engineering/>).

Where exposed soil is to be left for a long period of time before completion of the works or before seeding or planting can be established, other measures to prevent soil erosion may be required. This can include the use of:

- Geotextiles (biodegradable and non-biodegradable);
- mulching/binders/hydroseeding;
- turf cut from other areas on site where vegetation is being removed (can be reused elsewhere for permanent reinstatement as required);
- surface roughening/benching

PREVENT water polluted with sediment from leaving the site

There are many techniques and existing guidance to help minimise the mobilisation and loss of sediments/silt into waters. In certain circumstances it may be impossible or prohibitively expensive to prevent erosion of exposed soils. In such circumstances it is necessary to ensure that:

- water polluted by sediment is not allowed to leave the site untreated;
- the level of treatment is sufficient to ensure the final discharge is acceptable.

In most cases this will involve collecting the polluted run-off and routing it to treatment by filtration, settlement or specialist techniques (see Section 3.6). As well as treatment immediately prior to discharge, polluted water can be treated at source and en route to the discharge point – though this does not necessarily negate the need for further treatment before discharge. Widely used techniques include:

- diversion drains/ditches (see Figure 6);
- silt fence;
- fibre roll;
- filter bund;
- silt trap;
- haul routes and site entrances;
- surface drainage protection.

Diversion drains should be lined with a non-erodible material such as turf/geotextiles.

Figure 6 ✓ Good practice: diversion ditch along access road to intercept polluted water and carry to a treatment area



Haul routes, access roads and parking areas can generate significant quantities of water polluted with sediment. Being temporary in nature, they are often formed by simply stripping topsoil and grading the subsoil to suit. This means that during heavy rainfall surface run-off can erode the surface. The tracking of plant and machinery across wet or saturated soil can also loosen and mobilise additional sediment.

- Consider applying binder to road surfaces. This will also help to reduce dust pollution during dry weather.
- Shed water from roads onto adjacent vegetation or construct ditches along the road edge(s) to prevent uncontaminated run-off flowing onto the road and to direct contaminated run-off to treatment facilities. Do not allow roadside ditches to discharge directly to rivers, burns, lochs or wetlands.
- Prevent excess water running along the road by installing small earth bunds (like speed bumps) or cut-off ditches (see Figure 7) at regular spacing to direct water into roadside ditches.

Where haul routes cross watercourses, adopt measures to prevent sediment-laden run-off from entering them. This can be done by:

- Ensuring crossing structures have edge upstands or bunds eg straw bales, sandbags or earth;
- making sure bridge decks are sealed (see Section 3.7).

Where inlets to existing surface water drainage are present on-site (eg road gullies or yard drains), protect them from run-off polluted with sediment. This is best done by diverting the water away from the inlet to treatment facilities. Where this is not possible, create a bund around the surface water drain to prevent contaminated water entering.

Figure 7 ✓ Good practice: cut-off drain on haul route to prevent erosion and direct polluted surface water to diversion drains or treatment areas (photo courtesy of Scottish and Southern Energy)



Guidance on preventing pollution from construction sites

CIRIA publications – available from <https://www.ciria.org/>

- *Control of Water Pollution from Construction Sites – Guide to Good Practice* (SP156)
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- PPG5: *Works and Maintenance In or Near Water*
- PPG6: *Working at Construction and Demolition Sites*

PPGs are available from the NetRegs website (www.environment-agency.gov.uk/netregs/links/63893.aspx).

3.4 Isolation of works area

Where engineering works are carried out in or on the banks of rivers, burns, ditches, lochs and wetlands, it is often necessary to isolate and de-water the work area to create dry working conditions. Isolation of the works area reduces the risk of sediment entering the river or loch.

The first and most important consideration is whether it is possible to design out the need for such temporary works. This can be achieved by:

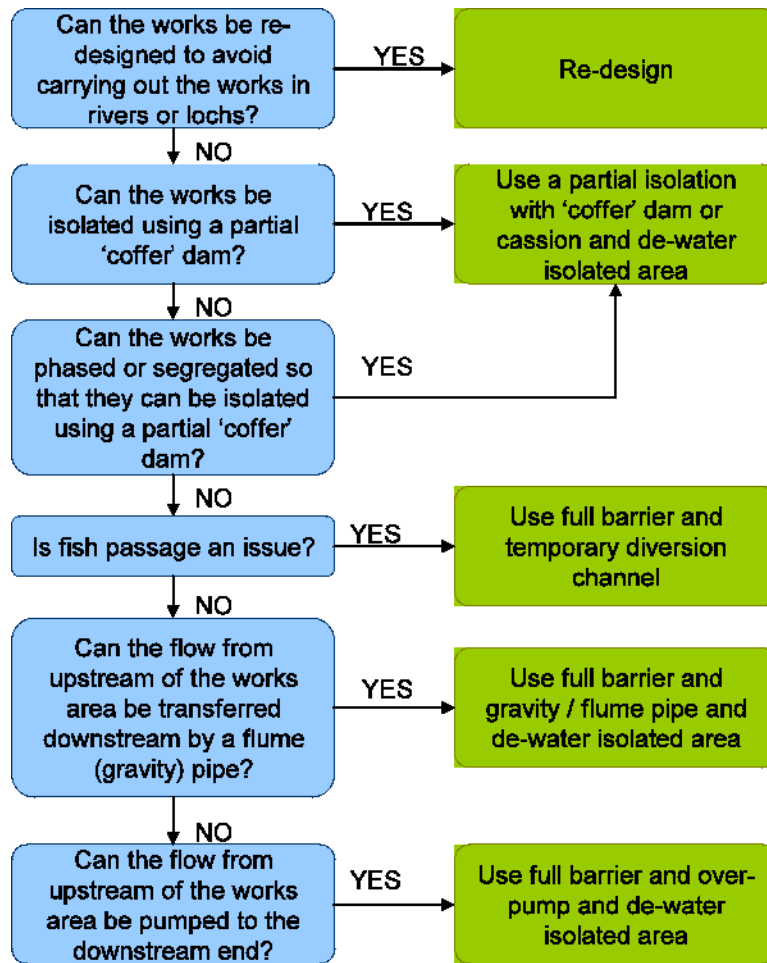
- considering alternative permanent works that do not encroach on the channel, loch or wetland (eg set back bridge abutments and single span bridges);
- using alternative construction methods (eg directional drilling or tunnelling rather than open cut excavation for pipe and cable crossings).

If temporary works in or on the banks of rivers, burns, ditches, lochs or wetlands are unavoidable, choose the isolation method that causes the least disturbance to the water

body but provides the highest level of pollution protection. The flow chart shown in Figure 8 will help select an appropriate method of isolation.

As well as initially de-watering the isolated work area, most of the isolation methods are likely to require continual or intermittent de-watering due to ingress of surface water, seepage or groundwater. Guidance on de-watering can be found in Section 3.5.

Figure 8 Choosing a method for isolating a works area in rivers or lochs



Figures 9 to 14 summarise the different isolation methods. The following sections present good practice guidance for the various methods.

Figure 9 ✓ Good practice: partial isolation/‘cofferdam’

Partial area of the channel is isolated and kept dry with the use of barriers (often referred to as a cofferdam) and flow is allowed to continue in the remainder of the channel. Barriers used to isolate part of the channel can be made of a number of different materials.

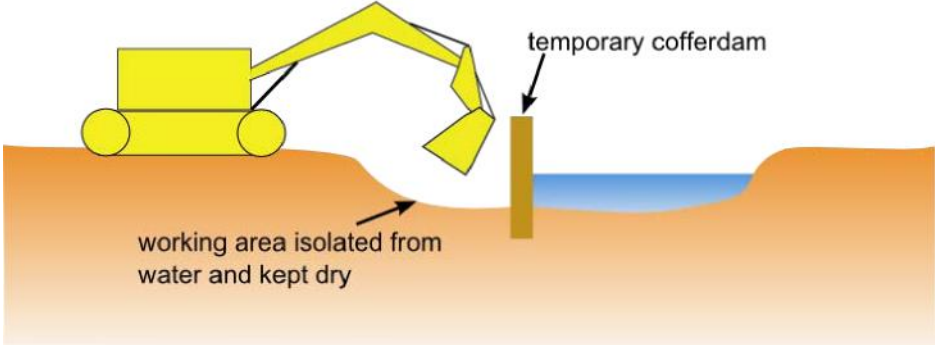


Figure 10 ✓ Good practice: partial isolation using a Caisson provides isolation of the channel similar to cofferdams. They are essentially large boxes or cylinders (usually pre-cast concrete and steel) which are open at the top and bottom and are lowered into the water to isolate an area of bed.

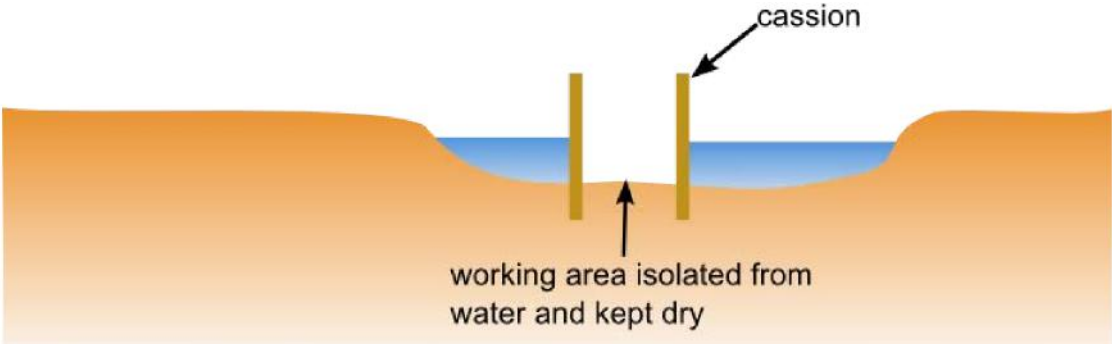


Figure 11 ✓ Good practice: full isolation temporary diversion channel

A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel.

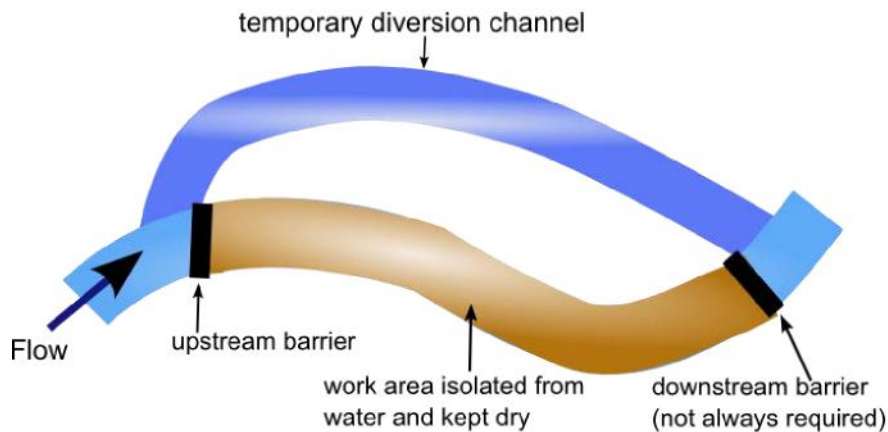


Figure 12 ✓ Good practice: full isolation gravity/flume pipe

A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area through gravity fed flumes/pipes. The flume(s) is normally placed on the bed of the watercourse through the works area and outfalls at the downstream barrier, if present, or far enough downstream to prevent the water backing up into the work area.

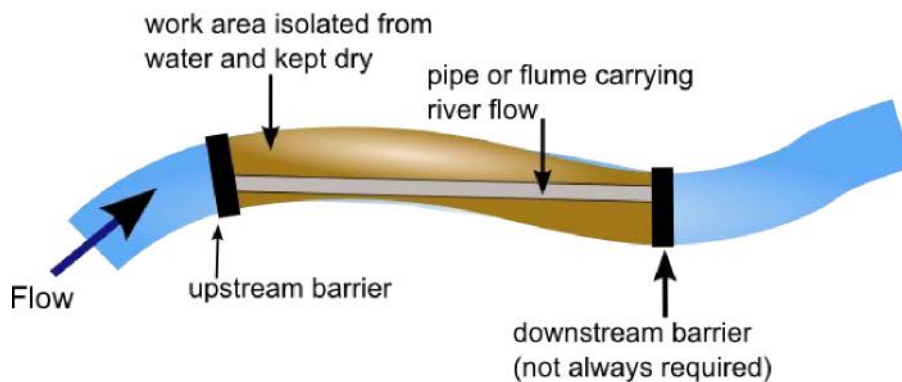


Figure 13 ✓ Good practice: full isolation over pumping / siphon

A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipework need not be located in the isolated area.

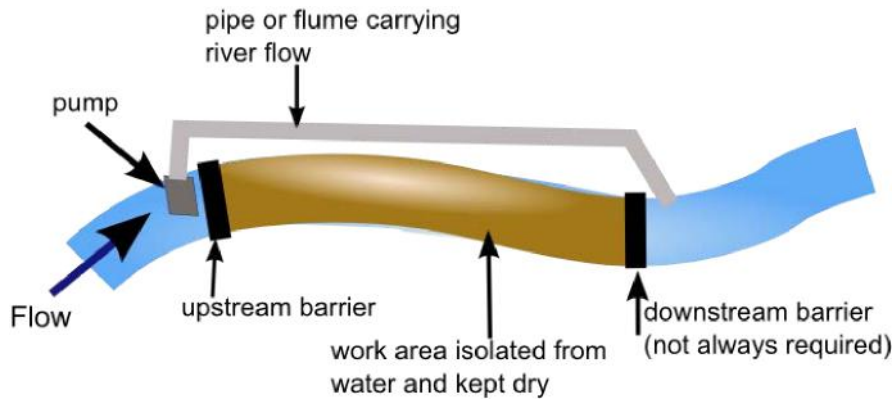
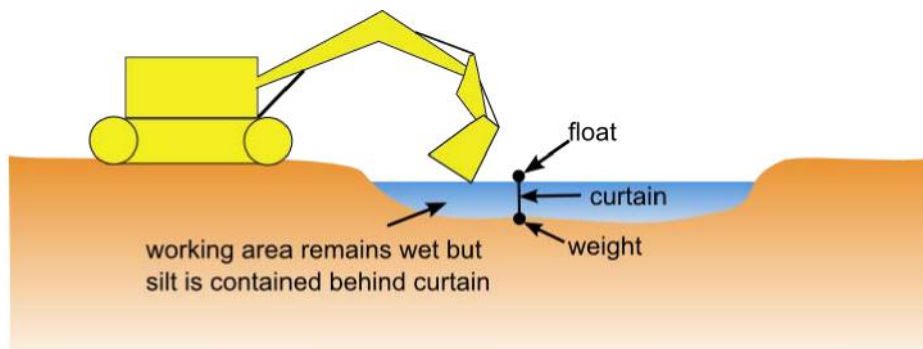


Figure 14 ✓ Good practice: isolation with silt curtain

In this case the works area still remains wet and a silt curtain is placed around the works area to minimise sediment being transferred downstream.



Partial isolation using a cofferdam

Figure 15 ✓ Good practice: steel piled cofferdam



A variety of methods using different materials are available to create temporary cofferdams:

- sandbag barriers;
- specialist dam structures on the river or loch bed (water filled membrane or steel, timber and concrete frame with impervious membrane);
- gravel, clay or earth bunds;
- steel, timber, concrete or plastic piled cofferdams;

A number of factors affect the choice of cofferdam material including:

- depth of water;
- available space;
- duration of works;
- bed conditions;
- accessibility;
- potential ingress of water.

Before choosing which method and material to use, it is also important to consider its potential impact on the water environment. The choice of material will depend on the conditions at a specific site.

The cofferdam must be designed by a competent person. The design should take into account:

- the reduction in channel capacity (for flood risk);
- the potential increase in flow velocity (for adjacent bed and bank erosion and toe scour);
- changes in flow patterns (for adjacent bed and bank erosion and toe scour);
- fluctuations in water level (for adequate freeboard);
- channel substrate (to avoid installation problems);

- alignment of the cofferdam, particularly at the upstream and downstream ends where bank erosion can be induced.

When determining the height of the barrier, make allowance for potential fluctuations in water levels (freeboard). Monitor the weather forecast and expected flows/water levels throughout the works and have a contingency plan in place to prevent damage or pollution during extreme weather and high flow events.

Inspect the barrier daily for movement, leakage and general deterioration. Take immediate remedial action to rectify any defects.

The work area must never be de-watered directly into any adjacent surface water. The removed water must receive treatment before discharge. See Section 3.5 for more guidance on de-watering.

After de-watering but before commencement of works, carefully remove the exposed bed material from areas which will be disturbed (particularly where plant will be operating) and stockpile it, to be used for reinstatement. Protect the stockpile from pollution or contamination. Note the elevation and distribution of the existing bed carefully and, if necessary, carry out a survey to ensure the bed profile can be reinstated after works using the original bed material where possible (see Section 3.8).

When the works are complete but before the barrier is removed, ensure all materials, debris, tools, plant and equipment are removed from the work area. Check the area thoroughly for spillages or potential pollution sources. Remove or clean up anything found.

Re-water the work area before removing the cofferdam to avoid sudden ingress of water causing erosion of the replaced bed or bank material. When re-watering, screen the pump inlets to prevent intake of fish or other aquatic animals.

The various materials used for cofferdams are discussed in table 1 below.

Table 1. Cofferdam barrier materials

| | | | |
|---------------------------|---|---|--|
| Sand bag barriers | <p>Advantages: Inexpensive Materials are readily available. Quick installation and removal for small-scale works. Minimal disturbance to bed. Can easily be shaped to tie in to banks</p> | <p>Disadvantages: Only suitable for relatively shallow water and small-scale works. Labour intensive installation and removal. Sandbags can rupture releasing sediment into the water. Prone to leakage. Large footprint required for deeper water.</p> | <p>Woven polypropylene bags are less likely to burst than hessian. They can be reused and give greater control over leakage of the fill material. The fill material should be dense and homogenous (typically coarse grain sand). The bags should be well compacted and knit together to take up gaps between bags. Place a geotextile filter or impermeable layer on the retained water side of the barrier to prevent seepage of silt through the barrier into the water. Ensure this layer is well-anchored along the base of the barrier and extends above the water line, where it should also be well secured.</p> |
| Specialist dam structures | <p>Advantages: Minimal disturbance to bed. Some systems can be reused at other projects or locations. Good seal achievable limiting the need for de-watering of the working area.</p> | <p>Disadvantages: Restriction on retained water height (approximate maximum 2–3m). Some systems are limited by flow velocity. Can be susceptible to movement or breach during flood flows.</p> | <p>There are several different proprietary dam systems available from different suppliers. These include steel framed structures with impermeable membranes and water filled membranes (Contact SEPA if water for water-filled structures is to be taken from rivers, burns, lochs or wetlands). Advice should be sought from a suitably qualified person for assistance with the design.</p> |
| Earth Bunds | <p>Advantages: Quick to install and remove. Good seal achievable with clay limiting the need for de-watering of the working area. Can be used on uneven beds. Can be installed from bankside using mechanical plant.</p> | <p>Disadvantages: Susceptible to washout of fine grain material and erosion from passing flow. Susceptible to leakage when sands or gravels are used. Washout due to leakage can also significantly weaken the bund leading to sudden failure. Damage/disruption to bed during installation and removal.</p> | <p>Gravel, clay and earth bunds have risk of causing sediments to pollute the water environment. When used, special precautions must be taken to prevent damage to the bed and release of sediment from the bund. A silt curtain or similar silt containment method (see below for further information) should be installed before the bund and must remain in place until after the bund is removed. For shallow water depths consider lining the waterside face of the bund with geotextile to prevent washout. Consider placing a geotextile or other durable material on the bed directly under the bund to help prevent damage to the bed during installation and removal.</p> |

| | | | |
|------------------|--|--|--|
| Piled cofferdams | <p>Advantages:</p> <p>Can be used in fast flowing or deep water. Minimal damage to bed during installation and removal.</p> <p>Minimal space required outside of minimum work area (if single line can be used).</p> <p>Can be installed from bankside.</p> | <p>Disadvantages:</p> <p>Specialist plant required for installation and removal.</p> <p>Susceptible to leakage through pile joints.</p> <p>Vibration and noise during installation.</p> <p>Subsurface obstructions (big boulders) can cause installation problems.</p> <p>Banks may need to be modified to create the upstream and downstream returns of the cofferdam.</p> | <p>Piled cofferdams are normally used for construction in deeper or particularly fast flowing water and / or where excavation below bed level is required for construction of the permanent works. Although it is possible to use timber and pre-cast concrete piles to construct cofferdams in water, the most common choice of material is steel sheet piles (see Figure 15). Plastic piles are also available.</p> <p>Piles can be placed in a single line or double skin with an earth fill between the skins.</p> |
|------------------|--|--|--|

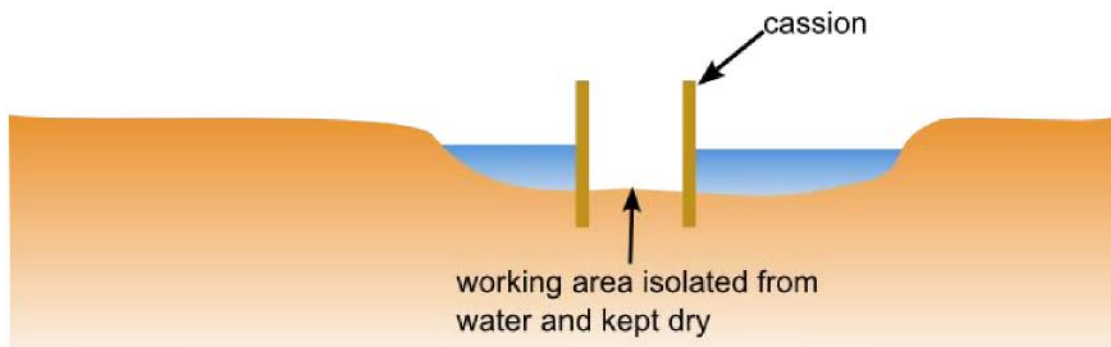
Source of further information on sheet-piled cofferdams

- *The Design and Construction of Sheet-piled Cofferdams, SP095M*, CIRIA, <https://www.ciria.org/>

Partial isolation using Caissons

Caissons offer partial isolation of the channel similar to cofferdams. They are essentially large boxes or cylinders (usually pre-cast concrete and steel) which are open at the top and bottom and are lowered into the water to isolate an area of bed (see Figure 16). The caisson can then be de-watered. The bed can also be excavated to create a working space below bed level. The caisson may also have an ‘air deck’ installed so that the compartment below the deck can be de-watered and filled with compressed air (similar to a diving bell) to prevent ingress of water and allowing working in the dry. The caisson can be used as part of the permanent works, eg permanent shuttering for bridge foundations. Caissons are generally only used for construction in deep water. It should be ensured that the caisson is free from dirt, dust, grease, oil or other chemicals when it is installed.

Figure 16 ✓ Good practice: typical use of a caisson



| Advantages | Disadvantages |
|--|--|
| Can be used in deep water | Expensive |
| Minimal damage to bed during installation | Access to working area can be difficult. |
| Can be used as part of the permanent works | |
| Can be made watertight. | |

Full isolation using a gravity/flume pipe

Figure 17 ✓ Good practice: sandbag barrier and gravity fed pipe (photo courtesy of Scottish and Southern Energy) and Figure 18 ✓ Good practice: full isolation of channel by gravity flume



Where it is necessary to isolate and keep dry an entire reach of river, burn or ditch, a barrier will need to be constructed across the full width of the watercourse upstream of the works area. In the vast majority of cases it will be necessary to transfer water from upstream of this barrier to downstream of the works area, ie maintain 'normal' flow in the watercourse either side of the isolated reach. Figure 17 and 18 show water transferred downstream with the use of a gravity fed pipe, ie there is no requirement for pumps to be used. Depending on the gradient of the watercourse, it may also be necessary to install a full width barrier downstream of the work area to prevent ingress of water. The methods available for creating full width barriers are largely the same as given in Table 1 above for partial barriers (cofferdams).

| Advantages | Disadvantages |
|--|---|
| Works by gravity (no pump required, reduces risk of equipment failing). | Causes a restriction within the working area. |
| Maintains some continuity in watercourse where passage of aquatic animals and fish is possible | Susceptible to blockage by trash at upstream end |
| | Potentially high flow velocities and turbulence at the flume outlet. |
| | Amount of water transferred is limited to the capacity of the flume. This limits the flow regime in which this technique can be used, ie a relatively predictable constant flow |
| | May need standby pumps |
| | Increased flood risk. |

The flume pipe must be designed by a competent person. The design should take into account the following aspects.

Flood risk

The nature of this type of isolation work means that the risk of flooding – particularly upstream – can be significantly higher. Great care needs to be taken with the design of the barriers and water transfer system and a carefully considered monitoring and contingency plan must be in place. This technique may therefore only be suitable for watercourses with low flows.

- Ensure measures are in place to deal with high flow situations and that the flood risk to surrounding property is not increased.
- Monitor the weather forecast and expected flows/water levels throughout the works.
- Put in place a contingency plan to prevent unplanned inundation of the work area during high flows, eg making the works secure and removing the flume pipe and barriers if high flows are expected.

Flow and erosion

There is a need to achieve a ‘balancing’ flow so that the alteration to upstream and downstream water levels is minimal. Put in place measures to dissipate energy at the downstream end of the pipe or pump to prevent bed or bank scour at the outlet.

Fish passage and wildlife issues

Programme the works to minimise disruption to the free passage of fish and aquatic animals. The most acceptable timing will depend on which sensitive species are present and should be agreed with SEPA, Scottish Natural Heritage (SNH) and the local District Salmon Fisheries Board.

- Keep the duration of the isolation works as short as possible.
- Screen the intake to prevent fish being drawn into the flume/pipe.

- Before the isolated area is de-watered, take appropriate measures to relocate any stranded wildlife. Consult SNH to establish relocation requirements.
- Ensure specialist techniques such as electro-fishing are carried out by suitably qualified personnel.
- Consider transplanting or watering sensitive aquatic vegetation in the isolated area if there is a risk that it will be damaged due to the removal of water.

Debris accumulation

To minimise trash and sediment accumulation at the upstream end, inspect the flume pipe (including the inlet and outlet) regularly for damage or blockage. Clear blockages and repair any damage immediately.

Flume/pipe condition

Leaks should be minimised.

- Inspect the flume pipe (including the inlet and outlet) regularly for damage, paying particular attention to joins and seals.
- Protect the flume pipe from crushing or impact damage. This may include:
 - aligning it away from plant movement and areas where work will be carried out;
 - using temporary barriers or protective covers.

Removal

Before removing the upstream barrier, remove any accumulation of silt or trash against the barrier and dispose of it appropriately. If a downstream barrier is present, remove this first.

Full isolation – over pumping/siphon

Figure 19 ✓ *Good practice: full isolation of channel by over pumping*



In some cases it will be necessary to pump water (Figure 19) from upstream of the barrier to downstream of the works area, ie maintain 'normal' flow in the watercourse either side of the isolated reach. Depending on the gradient of the watercourse, it may also be necessary to install a full width barrier downstream of the work area to prevent ingress of water. The

methods available for creating full width barriers are largely the same as given above for partial barriers (cofferdams).

| Advantages | Disadvantages |
|--|---|
| Pump and pipework can be kept out of the work area | Standby pumps are required in case of breakdown. |
| | Aquatic animals and fish can be harmed by being drawn into the pump(s). |
| | Potentially high flow velocities and turbulence at the downstream outlet introduces a discontinuity in the watercourse preventing the free passage of aquatic animals and fish. |
| | Alterations to local flow patterns cause induced or accelerated bed and bank erosion, or sediment deposition or increased flood risk. |
| | Prevention of free passage and potential harm to fish and aquatic animals. |
| | Disruption to aquatic and riparian animals due to continuous noise and vibration from pump(s). |

The size and type of pumps must be determined by a competent person and may require consultation with the pump manufacturers. The design should take into account the following aspects.

Flood risk

The nature of this type of isolation work means that the risk of flooding – particularly upstream – can be significantly higher. Great care needs to be taken with the design of the barriers and water transfer system and a carefully considered monitoring and contingency plan must be in place. This technique may only be suitable for watercourses with low flows.

- Ensure measures are in place to deal with high flow situations and that the flood risk to surrounding property is not increased.
- Monitor the weather forecast and expected flows/water levels throughout the works.
- Put in place a contingency plan to prevent unplanned inundation of the work area during high flows, eg making the works secure and removing the flume pipe and barriers if high flows are expected.

Flow and erosion

There is a need to achieve a ‘balancing’ flow so that the alteration to upstream and downstream water levels is minimal. If pumping, consider variable flow rate pumps.

Ensure pump outfalls and outfalls from any temporary treatment do not cause or generate erosion of the banks or bed. This can be done by using baffles or other energy dissipating devices and scour protection. Much of the guidance given for permanent outfalls can also

be applied to temporary outfalls (see SEPA Good Practice Guide WAT-SG-28, *Intakes and Outfalls*; <http://www.sepa.org.uk/regulations/water/engineering/>).

Debris accumulation

If pumps are used, accumulation of sediment/trash at the upstream end may affect pump performance and/or be transferred downstream with the pumped water.

- Inspect pipe/pump intakes regularly for blockages and clear immediately.
- Put in place measures to dissipate energy at the downstream end of the pipe/pump to prevent bed or bank scour at the outlet.

Fish passage and wildlife issues

Programme the works to minimise disruption to the free passage of fish and aquatic animals. The most acceptable timing will depend upon which sensitive species are present and should be agreed with SEPA, SNH and the local District Salmon Fisheries Board.

- Keep the duration of the isolation works as short as possible.
- Screen the intake to prevent fish being drawn into the pipe/pump.
- Before the isolated area is de-watered, take appropriate measures to relocate any stranded wildlife. Consult SNH to establish relocation requirements.
- Ensure specialist techniques such as electro-fishing are carried out by suitably qualified personnel.
- Consider transplanting or watering sensitive aquatic vegetation in the isolated area if there is a risk that it will be damaged due to the removal of water

Pipe/pump condition

Where pumps are used, make a competent person responsible for regularly monitoring the over pumping including:

- upstream and downstream water levels;
- flow rate;
- pump performance;
- inlet(s) and outlet(s);
- fuel level(s).

Minimise leaks from the pipework.

- Inspect the pipework (including the inlet and outlet) regularly for damage, paying particular attention to joins and seals.
- Protect the pipework from crushing or impact damage. This may include:
 - aligning it away from plant movement and areas where work will be carried out;
 - using temporary barriers or protective covers.

Removal

Before removing the upstream barrier, remove any accumulation of silt or trash against the barrier and dispose of it appropriately. If a downstream barrier is present, remove this first.

Pump operation

Ensure that any pumps and associated pipework used are emptied, thoroughly cleaned and dried before leaving the previous site, to minimise the risk of transferring water containing plant or animal diseases, or invasive non-native species, to the development site. On completion of work, all pumping equipment should be emptied, thoroughly cleaned (and preferably dried) before leaving site in order to prevent moving anything damaging to the next site at which it is to be used.

Pumping operations should avoid placing the inlet pipe amongst water plants and the pump inlet should be positioned just below the water's surface, rather than on the bed of the water body, to reduce the risk of non-native plant or animal species being taken through the pump.

Position standby pump(s) at the site of over pumping ready to be deployed if the main pump(s) fail. Test these standby pump(s) regularly. If the standby pump(s) are used to replace the failed main pump(s), bring additional standby pump(s) onto site.

Keep the pump(s) at least 10m from the edge of the channel and on drip trays or within bunds that have a capacity 110% of that of the fuel tank.

Suspend the inlet to the pump above the bed of the channel to avoid mobilisation of settled silt and sediment from the bed. The inlet could be suspended from an excavator arm or temporary support spanning the channel.

Screen the inlet to avoid intake of aquatic animals and check it regularly for blockages.

Avoid over pumping overnight or between shifts. Schedule the work so that there is 24-hour supervision of the over pumping or re-water the isolated area at the end of each day/shift. If re-watering is chosen, the design of the barriers must allow for continuity of flow through the isolated area while it is re-watered. Leave any works carried out in the isolated area between periods of re-watering in a state that will not cause erosion or displacement of the works, bed or banks.

Consider using a siphon system as an alternative to mechanical pumping. This will require:

- mechanical pumping to prime the siphon;
- a method for controlling the flow rate, eg a throttle or multiple siphon pipes.

Full isolation – temporary diversion channel

Figure 20 Full isolation by temporary diversion (NB The geotextile lining should extend to the full bank height and be properly secured.)



This method (see Figure 20) may also be more suitable for longer term isolation although in all cases works in the water must be kept to absolute minimum.

| Advantages | Disadvantages |
|---|--|
| Allows for continuity of flow and for large variations in flow rate including some flood flows. | A section of the existing banks must be removed at the start and end of the diversion. |
| Can be used where long duration isolation is | There is potential for induced bed and bank scour |

| | |
|---|--|
| required. | at the start and end of the diversion |
| Less risk of accidental inundation of isolated area than flume pipe(s) or over pumping. | Potential for silt being mobilised from the diversion channel. |
| Passage for fish and aquatic animals can be maintained. | |

It is essential that:

- the diversion channel is designed by a competent person with appropriate experience;
- a drawing of the diversion is produced showing plan views and cross-sections at regular intervals together with a longitudinal section;
- there is a specification for all materials used and a method statement describing the formation, use and reinstatement of the channel.

The design should take into account the following aspects.

Flood risk

This arises as a result of the hydrology of the watercourse and the potential for fluctuations in flow during the isolation works.

Make allowance for dealing with high flows particularly for long duration diversions. Justification for the chosen value of maximum flow will be required. Decide the chosen value by assessing the risk of high flows during the diversion. This value should take into account factors such as:

- the length of time the diversion will be in place;
- the time of year the diversion is in place;
- historical rainfall patterns for the catchment;
- historical flow data (where available);
- the effects of diversion channel overtopping.

Channel dimensions and design

- **Hydraulics and morphology of the existing channel** (eg gradient, water depth and velocity, channel cross-section and alignment, sediment transport and bed material). These should be replicated where possible in the diversion channel. The degree to which this is done will depend on the duration of the diversion, ie for longer duration diversions more effort must be made to replicate the existing channel. As a minimum, maintain the existing channel width and water depth (within reason) through the diversion channel.
- **Potential bank and bed erosion at the start and end of the diversion.** As noted above, every effort should be made to replicate existing bank conditions where possible. As general guidance, the bank slope should not be steeper than 1 in 2; this should be viewed in the context of the most geomorphologically suitable channel cross-section and plan form.

Channel excavation

Excavate the diversion channel in isolation from the watercourse, retaining 'plugs' at the upstream and downstream end until it is completed. Remove the downstream plug first and then the upstream plug.

Stockpile material excavated during formation of the diversion channel away from the channel edges to prevent sediment run-off during rainfall or high flows. Alternatively, protect stockpiles along the channel adequately to prevent sediment run-off.

Lining of channel

Line the excavated diversion channel **before** water is diverted into it to prevent mobilisation of silt and sediment. The lining should normally include a geotextile but, depending on hydraulics, may also be turf, vegetated matting, gravel/cobbles/boulders or a combination of these. Where geotextile is used, one piece should cover the whole channel where possible. Where this is not possible, place strips perpendicular to the flow with minimum 600mm overlaps (upstream piece overlapping downstream). Use gravel and riprap to hold the geotextile in place both on the bed and buried in trenches at the top of the banks. Bury the upstream end of the geotextile into a 600 × 600mm trench in the bed of the diversion channel.

Best practice is normally to line the bed of the diversion channel with suitably sized sediment similar to that in the isolated reach. This may not be necessary for very short duration diversions (eg those in place for only a couple of days) but would need to be justified on a case-by-case basis.

Careful design is required to ensure that the existing sediment transport regime is replicated as far as possible (ie it is important to ensure there is no significant increase in deposition along the diverted reach nor that sediment input from upstream is transported at a significantly increased rate through the diversion) as this could lead to significant geomorphological changes upstream and downstream. This will require the input of a suitably qualified person with relevant geomorphological experience. Include natural formations such as pools and riffles where appropriate.

Fish passage and wildlife issues

Programme the works to minimise disruption to the free passage of fish and aquatic animals. The most acceptable timing will depend on which sensitive species are present and should be agreed with SEPA, SNH and the local District Salmon Fisheries Board.

- Keep the duration of the isolation works as short as possible.
- Screen the intake to prevent fish being drawn into the flume/pipe.
- Before the isolated area is de-watered, take appropriate measures to relocate any stranded wildlife. Consult SNH to establish relocation requirements.
- Ensure specialist techniques such as electro-fishing are carried out by suitably qualified personnel.
- Undertake any in-stream wildlife relocation as the upstream and downstream (where used) barriers are put in place.

Monitoring

Make a competent person responsible for monitoring the diversion channel at regular time intervals. This should include:

- water levels (upstream, downstream and in the diversion);
- bank and bed erosion at the upstream and downstream ends;
- channel stability;
- trash accumulations.

Any problems should be communicated to the designer who should agree remedial works or alterations with SEPA.

Look out for debris and sediment accumulation in the diversion channel.

Isolation with silt curtain

This method should be used only in slow flowing water (lochs, large rivers) where no other isolation method to allow working in the dry is possible.

Make provision for removing the silt from behind the curtain before removing the curtain.

3.5 De-watering of isolated area

Isolated work areas and excavations must never be de-watered directly into adjacent or nearby rivers, burns, ditches, lochs or wetlands

De-watering is usually be carried out by mechanical pumping. It can involve:

- the initial removal of water from the isolated area behind a temporary barrier;
- ongoing removal of water from behind cofferdams, temporary barriers or excavations.

All discharges from de-watering must receive an appropriate level of treatment before discharge. Assess the pollutants likely to be present to identify the type of treatment required (see Section 3.6).

Under Controlled Activities Regulations, the discharge of water from any de-watering treatment must comply with General Binding Rule (GBR) 10 Discharge of Water Run-off. For more information, see the CAR Practical Guide available from the SEPA website (<http://www.sepa.org.uk/regulations/water/engineering/>).

Dewatering to enable working within a river does not require an authorisation for the abstraction of water under the Controlled Activities Regulations.

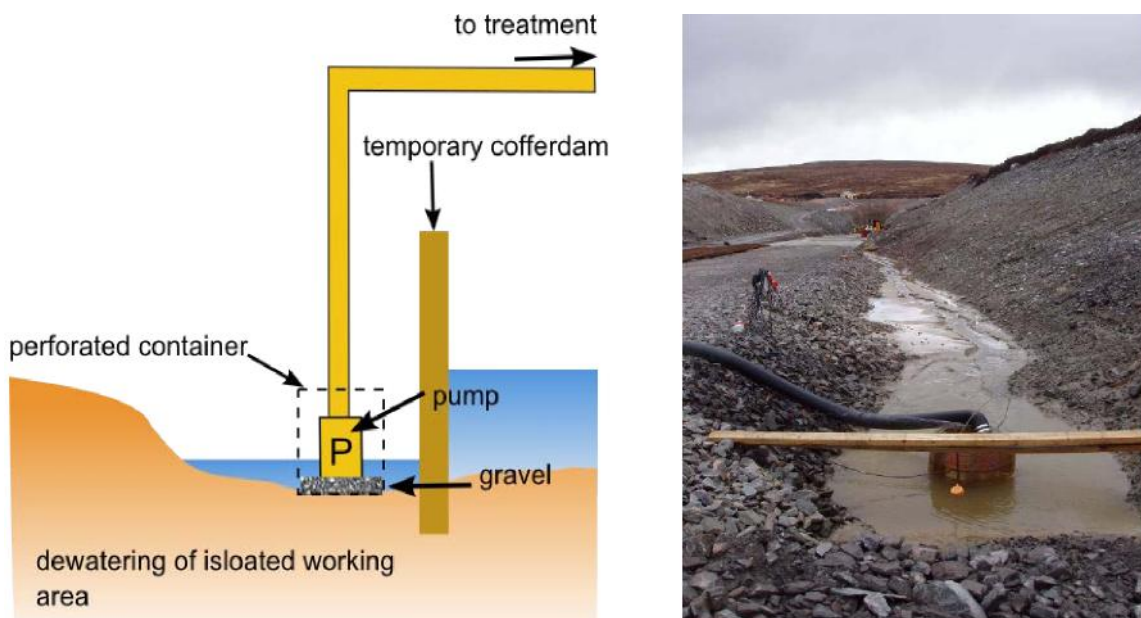
Adopt measures to minimise the ingress of water to the excavation or isolated area. This may include:

- ensuring cofferdams and barriers are well sealed;
- installing cut-off drains to prevent ingress of surface water.

Deep excavations may require specialist techniques such as cut-off walls or grouting to control the ingress of groundwater. SEPA must be consulted where this is proposed.

The use of submersible pumps, in particular, can mobilise silt into suspension through turbulence at or near the inlet. Where submersible pumps are used, place them in a sump that isolates them from the base of the excavation, eg on a gravel base inside a large diameter perforated pipe or manhole ring (see Figures 21 and 22) or suspended above the base of the excavation.

Figure 21 ✓ Good practice: typical submersible pump sump showing gravel base and perforated container and Figure 22 ✓ Good practice: pump intake located in a perforated barrel (photo courtesy of Scottish and Southern Energy)



Avoid using excavator buckets to de-water unless it is from an excavation away from a river, burn, ditch, loch or wetland and the water is discharged to nearby land or a constructed basin for treatment by filtration or settlement respectively (see Section 3.6).

Where pumps are used, ensure they are the correct size and type for volumes of water expected. Check the pump(s) and hose(s) regularly for leaks. Uncontrolled leakage can cause additional surface water run-off problems.

Ensure that pump outfalls and outfalls from any temporary treatment do not cause or generate erosion of land, banks or beds. This can be done by using baffles or other energy dissipating devices and scour protection. Much of the guidance given for permanent outfalls can also be applied to temporary outfalls (see SEPA Good Practice Guide WAT-SG-28, *Intakes and Outfalls*; <http://www.sepa.org.uk/regulations/water/engineering/>).

3.6 Treatment and/or disposal of contaminated water

Under the Controlled Activities Regulations and General Binding Rule (GBR) 10, discharges of run-off water from construction sites are required to be treated by a Sustainable Urban Drainage System (SUDS) or equivalent. For more information see the CAR Practical Guide available from the SEPA website (<http://www.sepa.org.uk/regulations/water/>).

Contaminated water must be dealt with in accordance with the relevant waste regulations including:

- Environmental Protection Act 1990;
- Controlled Waste Regulations 1992 (as amended);
- Special Waste Regulations 1996 (as amended);
- Waste Management Licensing Regulations 1994 (as amended).

As stated in Section 1, this Guide focuses on temporary works required for the construction of engineering activities in river or lochs. It does not cover pollution prevention measures for the whole construction site. This section describes some basic principles but does not go into detail on the treatment and disposal of contaminated water from the wider construction site as there is already considerable existing guidance on this subject which should be followed (see box on sources of further information at the end of this section).

All potential sources of pollution should be identified at the planning stage and appropriate treatment or disposal methods decided.

At the pre-planning/planning stages of construction projects, consider the use of SUDS as means of treating surface water from the completed structure (where appropriate). Where SUDS are to be included as a permanent feature (eg ponds or wetlands) it should be possible to make use of the area designated for the SUDS to deal with contaminated run-off from the building site.

Avoid and minimise the generation of contaminated water as described in Section 3.3.

As discussed in Section 2, contaminated water can arise from a number of sources including:

- direct disturbance of the river bed or bank;
- de-watering of excavations;
- run-off from exposed ground and material stockpiles;
- run-off from roads and haul routes and river crossings;
- plant washings;
- fuel and chemical storage/refuelling areas;
- leaking/vandalised equipment.

Appropriate treatment or disposal options will depend on a number of factors including:

- volume of water;
- type of pollutant;
- area of land available for treatment/discharge;
- amount and type of silt.

A combination of treatment and disposal methods is likely to be required.

Treatment and disposal methods include:

- discharge to sewer;
- tanker off-site;
- sustainable drainage systems (SUDS);
- disposal of water off-site;
- settlement lagoons;
- filtration including mechanical filtration;
- infiltration/pump to grassland.

Discharge to foul sewer

Contaminated water can be pumped or drained to the public sewer. Permission to discharge to the public sewer must be obtained from Scottish Water (www.scottishwater.co.uk).

Tanker off-site

Water can be stored on-site, then pumped into tankers and taken away for disposal elsewhere at appropriately authorised off-site facilities.

Sustainable drainage systems

SUDS is the practice of controlling surface water run-off as close to its origin as possible by slowing flows, allowing adequate settlement and in certain cases some biological action to take place before water is discharged.

Under General Binding Rule (GBR) 10 of the Controlled Activities Regulations, discharges of run-off water from construction sites are required to be treated by a Sustainable Urban Drainage System (SUDS) or equivalent.

Settlement ponds and tanks

To remove sediment from water by settlement, the water needs to be retained in an undisturbed state (ie not moving) for a period of time. This allows particles to fall out of suspension. The rate at which they fall out depends on size, with finer particles taking longer to settle. Also, the deeper the water the longer it will take for particles to settle. Other factors affecting settlement include temperature, particle density and water disturbance.

Settlement ponds and tanks must be large enough to allow retention for sufficient time for the particles to settle. This may require the use of ponds or tanks in series (see Figures 23 and 24 respectively) or baffles or other methods to extend through flow and thus treatment to allow effective settlement.

If the use of flocculants is proposed, contact SEPA in advance to discuss any risks as these agents can be polluting/toxic.

Figure 23 ✓ Good practice: series of settlement ponds



Figure 24 ✓ Good practice: settlement tanks (photo courtesy of Scottish and Southern Energy)



Filtration

Limited volumes of contaminated water can be passed through a filter medium to remove sediment. Suitable filtration media can include straw bales, single sized aggregate (5--10mm) or geotextiles. Mechanical filtration units can also be used and are available from a number of different suppliers. These can be used in single units or joined together for larger volumes.

Infiltration/pump to grassland

The suitability of this method depends on a number of factors including:

- gradient of ground;
- type of vegetation and soil;
- condition of ground (the method is not effective if the ground is saturated due to wet weather).

Contact SEPA for advice before carrying this out.

Guidance on treatment/disposal of contaminated water from construction sites

CIRIA publications – available from <https://www.ciria.org/>

- *The SUDS Manual* (C697)
- *Site Handbook for the Construction of SUDS* (C698)
- *Control of Water Pollution from Construction Sites – Guide to Good Practice* (SP156)
- *Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors* (C532)
- *Control of Water Pollution from Linear Construction Projects – Technical Guidance* (C648)
- *Control of Water Pollution from Linear Construction Projects – Site Guide* (C649)
- *Environmental Good Practice – Site Guide* (C650)

Pollution prevention guidance published jointly by Environment Agency, SEPA and Environment and Heritage Service:

- *Getting Your Site Right. Industrial and Commercial Pollution Prevention.*
www.environment-agency.gov.uk/static/documents/Business/pp_pays_booklet_e_1212832.pdf
- PPG5: *Works and Maintenance In or Near Water.*

PPGs are available from the NetRegs website (www.environment-agency.gov.uk/netregs/links/63893.aspx).

3.7 Temporary river crossings

The same principles of good practice apply to permanent and temporary river crossings. Refer to SEPA Good Practice Guide WAT-SG-25, *Construction of River Crossings* (<http://www.sepa.org.uk/regulations/water/engineering/>) for more detailed guidance.

The first thing to consider is whether a river crossing is required at all.

- Works should be carried out from the banks where possible.
- Where rivers are required to be crossed, existing bridges should be used where possible.

Where there is no existing permanent bridge, a temporary crossing should be constructed. The river should not be forded as this poses a high risk of sediment getting into the river.

Provide temporary haul road bridges, etc with splash plates to prevent vehicular traffic from pushing debris over the edge and into waters.

- Where fish are present and the temporary crossing will be in place during times when fish are migrating, a span structure should be used (see Figure 25).
- If a culvert is used (see Figure 26), it must be designed and constructed so that fish can pass.
- A piped ford/causeway (see Figure 27) should not be used if fish passage is an issue.

Figure 25 Span structures

These include single span structures and structures with in-stream supports. Span structures extend across the width of the channel and have least impact on the river channel. They come in a variety of forms such as pre-cast panel bridges and pre-cast bottomless arch culverts. In-stream supports are available for pre-cast panel bridges. Some may have pre-fabricated foundations or may require foundations to be constructed on site. They can also be built for site-specific requirements.



Figure 26 Closed culverts

Closed culverts have a greater impact on the bed and banks of the river. They can be made from a variety of materials and come in a range of shapes and sizes. Installation of closed culverts causes a significant impact on the river bed and, if not designed/installed correctly, can act as a barrier to fish migration.



Figure 27 Piped fords/causeways

Piped fords/causeways involve raising the crossing above the level of the bed, often using multiple pipes.



General best practice for temporary crossings is summarised below. This is followed by good practice guidance for the three main types of temporary crossings (ie span structures, closed culverts and piped ford/causeway).

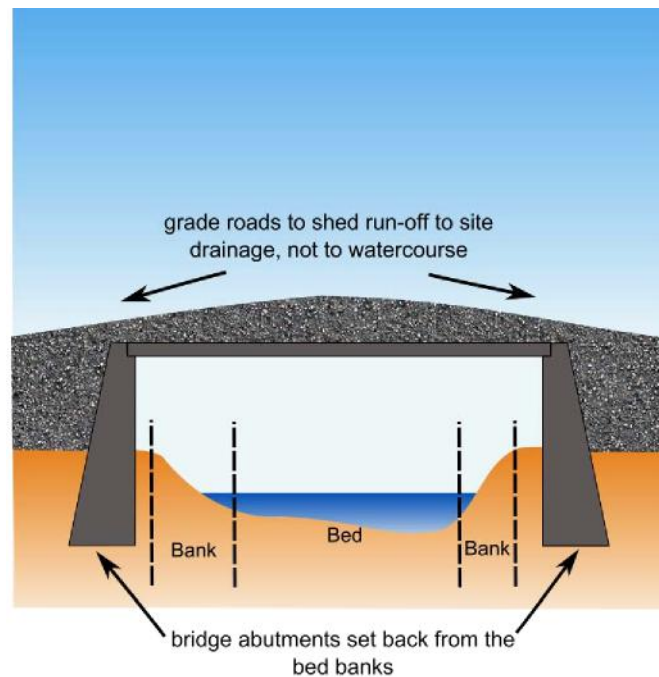
General guidance

Prevent road run-off from entering watercourse

Pay particular attention to preventing silty or sediment laden run-off from temporary crossings entering watercourses.

- The deck should be sealed or lined.
- The deck should have an edge upstand (eg steel plate, timber, straw bales, sandbags, geotextile).
- The road surface should be on a slight gradient/graded to ensure that surface water is not shed into the watercourse but is routed beyond the top of the river bank into site drainage which has the appropriate form of treatment (see Figure 28).

Figure 28 ✓ Good practice: crossing road graded to shed water to site drainage, not to watercourse
watercourse



Reduce risk of erosion

To reduce the risk of bed and bank erosion at the crossing:

- avoid crossings over active areas, particularly on the outside of meander bends;
- make the crossing perpendicular to the river to:
 - ensure the crossing is as short as possible – reducing impact and, in some instances, cost;
 - reduce the risk of localised scour at the structure;
- avoid realignment of the river;
- consider modifying the crossing point and crossing alignment.

Flood risk

In general, environmental impact from temporary crossings will be more likely during high flows than low flows. Good practice design, as for permanent crossings, will mitigate potential environmental damage due to low flows in temporary crossings.

Inappropriately sized crossings can cause flooding by being too small to cope with the flow and/or becoming blocked by debris. Such flooding can then cause:

- water pollution from construction materials, equipment and processes on a flooded site;
- damage to the construction works;
- damage to adjacent property;
- damage to downstream property due to surges caused by sudden failure or debris mobilisation;

- increased flood risk upstream.

It is important to understand the hydrology of the watercourse being crossed in order to assess the range of flows likely during the temporary works and the associated risks. This can be done by:

- examining any available flow and rainfall records;
- collecting anecdotal or photographic evidence of previous high flows/flooding;
- undertaking hydrologic calculations.

This work should be carried out by a suitably qualified professional (eg hydrologist, chartered civil engineer).

Removal of temporary crossings

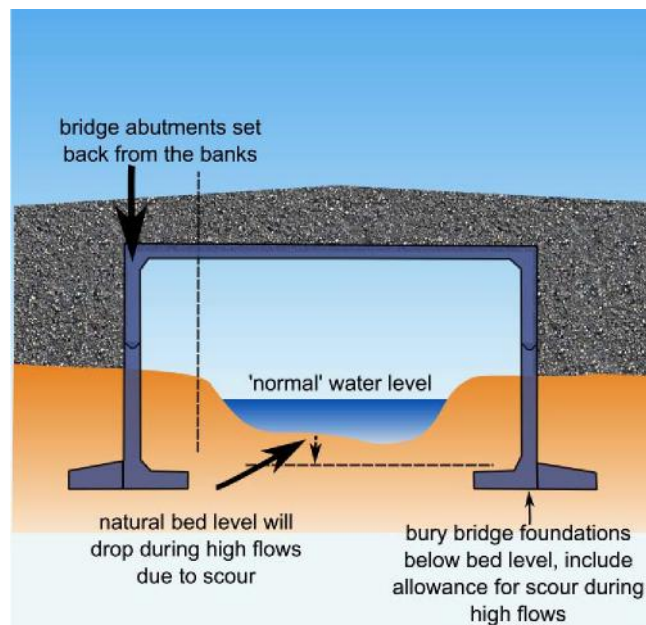
The installation of temporary crossings will inevitably alter elements of watercourse morphology, even if just temporarily. It is therefore vital that:

- the crossing is in place for the minimum period necessary;
- upon its removal, the watercourse is reinstated as close to the pre-installation situation as possible.

Refer to Section 3.8 for further guidance.

Good practice for span structures

Figure 29 ✓ *Good practice for span structures including bridges and bottomless arch culverts.*



The following principles should be followed for all types of single span structure.

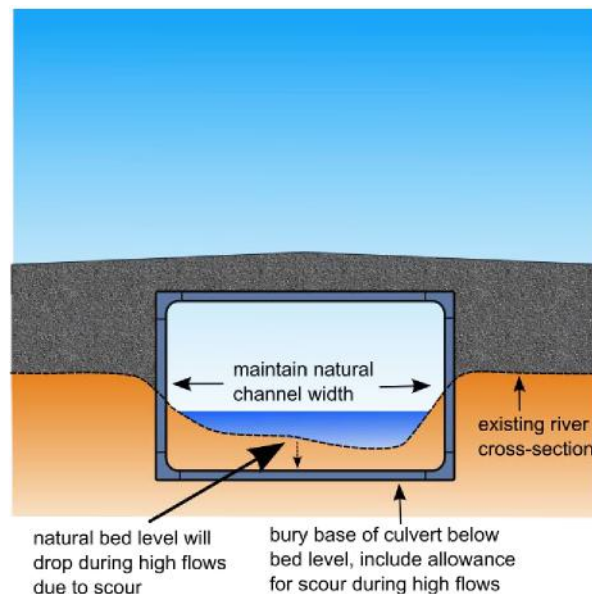
Set back abutments from the river channel and bank to allow the continuation of the riparian corridor underneath the bridge. This helps to minimise/prevent the need for bank reinforcement (and allows for mammal passage).

Bury foundations deep enough to minimise/prevent the need for bed or bank reinforcement or bridge weirs. This maintains the natural bed sediment and bed levels, protecting habitat and allowing fish passage.

The depth below the bed that the foundations should be buried will depend on site-specific conditions. Use appropriate methods to calculate this depth, taking into account scour during high flows. Design any in-stream supports/piers to facilitate the passage of large woody debris (LWD) by streamlining the upstream facing side.

Good practice for closed culverts

Figure 30 ✓ Good practice: closed culvert



If not designed properly, closed culverts have a high risk of posing a barrier to fish passage. Following the advice given below will reduce this risk.

Design culverts so that they are passable under the normal conditions in which fish would be expected to pass. They should be passable to all fish. Successful fish passage requires the following factors to be acceptable:

- no physical obstructions to passage, eg avoid 'perching' – this is where there is a drop or cascade at the culvert outlet (downstream end) due to erosion of the river downstream;
- adequate water depth;
- appropriate water velocity;
- adequate resting places above and below the structure.

Following the guidance below will help ensure these factors are acceptable for fish passage. Figure 30 summarises this guidance.

Specific requirements will depend on the species of fish. *River Crossings and Migratory Fish: Design Guidance* (www.scotland.gov.uk/consultations/transport/rcmf-00.asp) gives more information.

Maintain natural bed level

Bury the culvert base below the natural bed level to allow this to be maintained (see Figure 30). It should be buried sufficiently deep to allow a natural bed to be maintained during high flows. The culvert should be sized to carry both flood flows and bed material.

Also maintain the natural slope of the river. Burying the culvert base and maintaining the natural bed level will help retain the natural slope.

Maintain natural channel width

The culvert should maintain the natural channel width, as culverts that are too wide or too narrow can lead to an increased risk of erosion.

Ensure natural low flow depths are maintained through the culvert, if necessary by the use of a two-stage channel.

Use single barrel culverts as fish prefer larger barrel sizes and can be discouraged from entering smaller size diameters.

Other mitigation measures

The culvert soffit (top) should be higher than the natural bank height.

Check water velocities and depths in the culvert under different flow conditions (under which fish would be expected to seek passage) to ensure they are adequate for fish passage.

For longer culverts or culverts where depth/velocity is an issue, provide baffles or other mitigation measures. If trash screens are required, it is also necessary to take bar spacing and fish passage into account. Ensure at least 230mm spacing between each bar.

Mammal passage

Also consider mammal passage. Mammals such as otter and water voles should be able to pass through the culvert on a dry area under higher flow conditions.

Scour protection

Minimise the potential for localised bed and bank erosion (scour) around the crossing structure through careful consideration of the location (avoid active areas) and design (ensure foundations are deep enough) as discussed above.

If bed reinforcement is deemed necessary, lay this below the natural river bed level so that the natural bed level can be maintained.

Where bank protection is necessary, see SEPA Good Practice Guide WAT-SG-23: *Bank Protection: Rivers and Lochs*

[\(http://www.sepa.org.uk/regulations/water/engineering/\)](http://www.sepa.org.uk/regulations/water/engineering/)

Good practice for piped fords/causeways

Figure 31 ✓ Good practice piped ford / causeway



Do not use piped fords/causeways if fish passage is an issue at the site. Such crossings are only suitable in shallow waters. They should be located at 'natural crossing points', ie where the river is naturally wide and shallow (riffles), although care should be taken to avoid fish spawning areas or the time between fish spawning and emergence.

Do not move bed material from one location to another to form a shallow area for crossing.

3.8 Re-instatement of bed and banks

The vast majority of engineering works in rivers and lochs will result in physical changes to the bed and banks of the worked area. When the permanent works are complete, the bed and banks of rivers and lochs should be appropriately reinstated.

Appropriate surveys should be carried out before the works commence to ensure the site can be reinstated to its pre-works condition and for monitoring purposes. These surveys should include:

- photographs of the site;
- information on existing vegetation;
- information on existing habitat;
- watercourse information including:
 - substrate type (size distribution);
 - planform;
 - cross-sections;
 - existing erosion and deposition;

- typical water levels.

Allow adequate time and resources in the works programme for reinstating and clearing up the site – removing all construction waste, including any contaminated soil, excess materials and equipment before leaving.

Consider resources for post-works monitoring and maintenance of reinstatement works to ensure the actions taken become well-established and stable (particularly on river banks).

If possible, programme reinstatement works to finish around April or May in order that:

- vegetation has a full growing season to become established;
- the risk of high flows and heavy rainfall is less for the first 3 or 4 months after planting or sowing.

River channel

The channel should have the same cross-section as it did pre-works. This not only relates to capacity but also to any features the channel has such as low flow berms/deeper pool areas, islands and bars.

Banks

The **slope of the banks** should be profiled to the same incline as they were before works started.

Native locally sourced **vegetation** should be re-established.

- Take the time for vegetation to re-establish into account.
- Avoid exposed soils (see Figure 32) – see Section 3.3 for more details on reducing erosion from exposed soils. To avoid exposed soil, consider using:
 - pre-grown reinforced turf or vegetation;
 - dense vegetation planting;
 - hydro seeding;
 - biodegradable soil reinforcement (see Figure 33).

See SEPA Good Practice Guide *Riparian Vegetation Management (WAT-SG-44)* (<http://www.sepa.org.uk/regulations/water/engineering/>) for more information.

Figure 32 *X* Poor practice: exposed soils leading to erosion and sediment input



Figure 33 *✓* Good practice: (left) initial installation of biodegradable matting preventing erosion of soil, photo on right shows matting after initial establishment of vegetation



Bed reinstatement

The existing bed material from the pre-works site should be stored and kept clean. It should be reinstated once work has finished.

If the existing bed material is silt/sand it may not be suitable for re-instatement. Clean appropriately sized material can be sourced when reinstating this kind of bed material.

Wherever practical, source imported bed material from local quarries to:

- ensure it is of a similar nature/chemistry to the original natural river bed;
- reduce transportation costs.

The bed profile should be carefully reinstated to what it was before construction work began.

Further sources of information on re-instatement of bed and banks

SEPA Engineering in the Water Environment Good Practice

Guides: <http://www.sepa.org.uk/regulations/water/engineering/>

- *Bank Protection: Rivers and Lochs* (WAT-SG-23)
- *Riparian Vegetation Management* (WAT-SG-44)

Other publications

- *Manual of River Restoration Techniques*, River Restoration Centre, 2002.
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- *The Use of Vegetation in Civil Engineering*, C708, CIRIA, 2007.
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- PPG2: *Above Around Oil Storage Tanks*
- PPG5: *Works and Maintenance In or Near Water*
- PPG6: *Working at Construction and Demolition Sites*
- PPG7: *Refuelling Facilities*
- PPG8: *Safe Storage and Disposal of Used Oils*
- PPG18: *Managing Fire Water and Major Spillages*
- PPG 21: *Pollution Incident Response Planning*
- PPG26: *Storage and Handling of Drums and Intermediate Bulk Containers*.

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Appendix 1: Feedback form – Good Practice Guide WAT-SG-29

SEPA is committed to ensuring our Good Practice Guides are useful and relevant to those carrying out activities in Scotland's water environment.

We welcome any comments you have on this Good Practice Guide so that we can improve future editions.

After completing the short questionnaire, please detach it and post to the address below or fax it to 01355 574 688.

SEPA
WFD Administration Officer
5 Redwood Crescent
Peel Park
East Kilbride
G74 5PP

The aim of this Good Practice Guide is to provide guidance on the sustainable management and establishment of, vegetation in the riparian zone of rivers, lochs and wetlands for the benefit of the environment and people.

1. Which of the following do you think describes how well the Guide meets these aims?

Excellent _____ Good _____ Average _____ Poor

2. How relevant was the content of the Guide to your activity?

3. What elements of the guidance did you find most useful?

4. What elements of the guidance did you find least useful?

5. Did you find the Guide clear and easy to follow?

Yes _____ Sometimes _____ No _____

6. If there were areas that could be clearer, please let us know in the box below

7. Were there issues you felt should have been covered, omitted or dealt with differently in the Guide?

Please use the box below for other comments or suggestions on the Guide (continue on a new sheet if required).

