LANDSCAPE SOUTH AUSTRALIA
MURRAYLANDS AND RIVERLAND

Guideline for the Construction of Low Flow Bypass Devices

Technical Fact Sheet for Off-Stream Dams

What is a low flow bypass?

A low flow by-pass is a device used to prevent a water storage, dam or other form of diversion from harvesting low flows (sometimes called environmental flows). These low flows are critical in maintaining our sensitive water dependant ecosystems.

Threshold flow rate

This is the rate of water flow which must be exceeded before water can be harvested or collected. It is normally measured in litres per second (l/s) and the required rate will be specified in your Water Affecting Activities Permit.

When does this fact sheet apply?

Watercourses and dams or diversions have many forms. Three fact sheets have been prepared to cover most situations.

These are:

1. On-stream dams (1 to 70 l/s)
2. Off-stream dams (10 to 520 l/s)
3. Off-stream dams with 50:50 flow split
   (5 to 2000 l/s)

It is not anticipated that the design in this fact sheet will be appropriate for all dams. Some dams will require a special design to suit the local conditions.

This fact sheet applies to off-stream dams or diversions built on catchments where the watercourse has a defined channel with bed and banks.

The device also requires a flat area on which a dam, pumping pool or other form of diversion can be formed. This fact sheet is appropriate for diversions with a threshold flow rate of 10 and 900 l/s. If the conditions detailed on this fact sheet cannot be met for your site, this design may not be appropriate and you should use another fact sheet or consult a qualified engineer to help develop a special design.

If your permit specifies that you can harvest no more than 50% of the flow at any one time, use Fact Sheet 3.

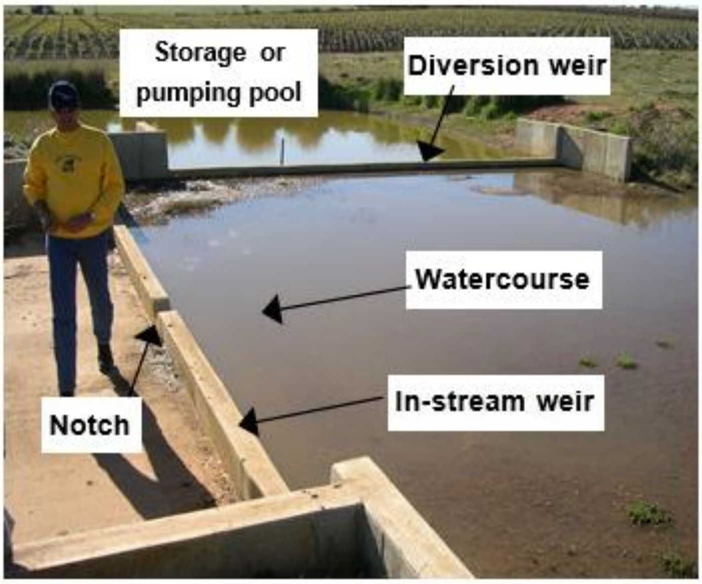


Figure 1: Example of a structure

How does the device work?

Water is diverted from the watercourse using weirs. Two weirs are used to control flow; an in-stream weir and a diversion weir. Low flows accumulate behind the in-stream weir and pass through an orifice (hole) in the weir.

As flows increase to the threshold flow rate, water levels behind the in-stream weir increase. At flow rates above the threshold flow rate the water level rises above the level of the diversion weir and water is diverted. As flows increase further, the in-stream weir is overtopped and flows carry on down the watercourse.

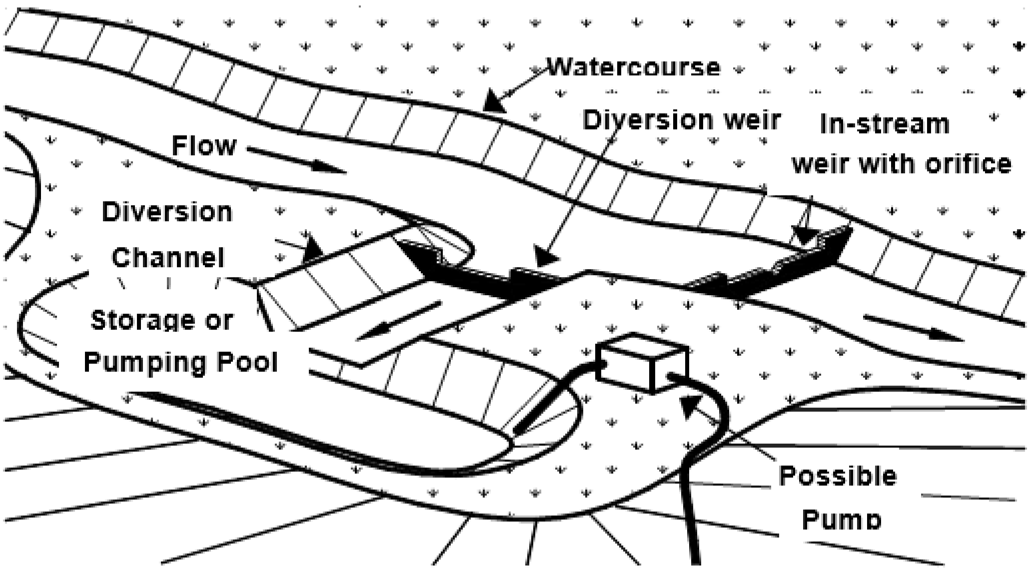


Figure 2: Layout of a typical structure

Design and construction

The weirs can be constructed from reinforced concrete or durable hardwood timber. Timber structures may be built by skilled handy-people whilst concrete structures must be built by an experienced builder or civil works contractor.

Functional Details

Introduction

This design uses two weirs to control flows; an in-stream weir and a diversion weir. Guidance on determining the appropriate weir dimensions and levels is provided here. Structural design information is provided later in this fact sheet. This type of low flow bypass device requires a watercourse with defined channel and flat floodplain on which a dam can be dug.

In-stream weir crest level

The first step in design is to determine an appropriate in-stream weir crest level. If the level is too high the weir will represent a significant constriction to flow and result in erosion. If the weir is too low it will not be possible to divert water into the dam. Determining the right level requires some thought and observation of your watercourse. It is important to understand the fluctuation in water level in response to changes in flow rate.

It is intended that the in-stream weir is submerged regularly in wet times, and on a number of occasions during an average or wet year. The weir level must be no higher than half way between the typical low flow water level during winter and the typical high flow water level during winter. The low flow water level is the water level that you would expect once water levels have receded after heavy rainfall. The high flow water level is the water level you would expect after a period of heavy rainfall. Flood levels would be higher than this level. For structural reasons the weir must not be higher than 1 m.

Orifice height

The bottom of the orifice (hole) in the in-stream weir should be set to the typical low flow water level during winter, as described above.

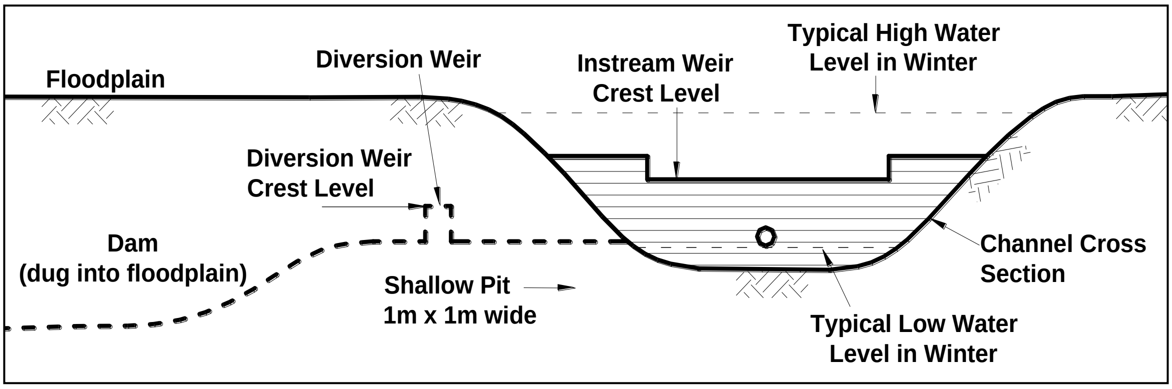


Figure 3: In-stream weir details

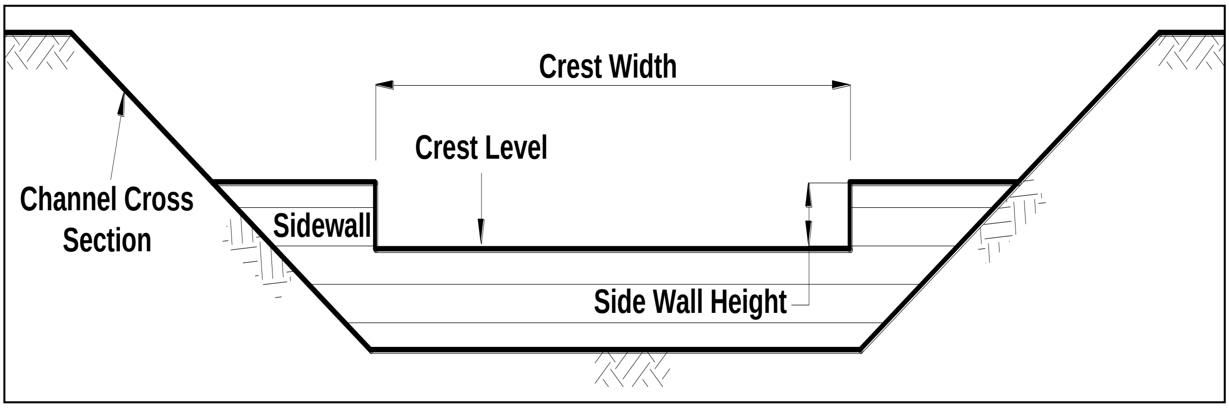


Figure 4: Diversion weir details

Diversion weir crest level

The diversion weir crest level must be below the in-stream weir crest level. The diversion weir crest level will also be the storage level in the dam. Whilst the dam may fill to a higher level during periods of high flow in the watercourse, this level will recede to the diversion weir crest level as water levels recede in the watercourse. Stop logs may be used to prevent water levels receding in this manner. The diversion weir crest level must be at least 30 cm above the bottom of the orifice in the in-stream weir.

Orifice size

The height difference between the bottom of the orifice (i.e. winter low flow water level) and diversion weir crest level is called the 'orifice head'. Calculate your orifice head and use this information, together with your required low flow threshold, to determine your required orifice size using Figures 5, 6 or 7.

Side walls

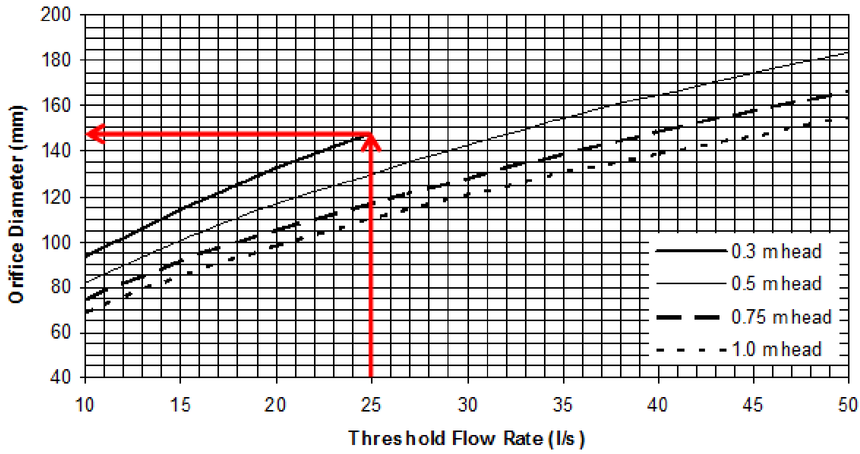
The sidewalls are used to concentrate flows in the centre of the creek and direct flows away from the banks, reducing bank erosion. Side walls should each be 1/6 of the watercourse width at weir crest level. The weir crest is then 2/3 of the watercourse width. The side wall height should be between 10 and 30 cm. For timber structures it can be the width of one sleeper. Crest is then 2/3 of the watercourse width. The side wall height should be between 10 and 30cm. For timber structures it can be the width of one sleeper.

Storage depth

The maximum storage depth is the depth of water between the bottom of the dam and the diversion weir crest level. Together with the dam area this will govern the dam volume. As the diversion weir crest level will often be relatively fixed by the constraints described above, to increase the depth the dam will need to be dug deeper.

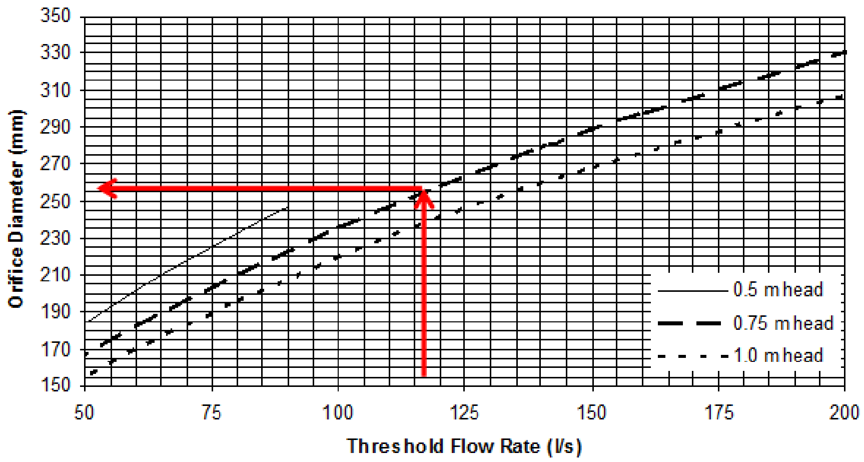
DESIGN DIMENSION FIGURES

Figure 5: Orifice Diameter versus Threshold Flow Rate (10 – 50 l/s)



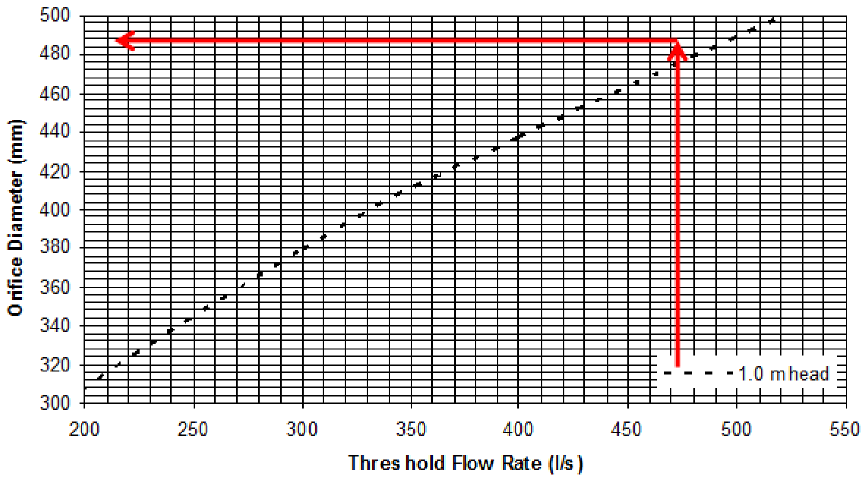
Example:
For a threshold flow rate of 25 l/s and an orifice head of 0.3 m, the orifice diameter is 147 mm. Other orifice heads will give different orifice diameters for the same flow rate.

Figure 6: Orifice Diameter versus Threshold Flow Rate (50 – 200 l/s)



Example:
For a threshold flow rate of 115 l/s and an orifice head of 0.75 m, the orifice diameter is 255 mm. Other orifice heads will give different orifice diameters for the same flow rate.

Figure 7: Orifice Diameter versus Threshold Flow Rate (200 – 900 l/s)



Example:
For a threshold flow rate of 460 l/s and an orifice head of 1.0 m, the orifice diameter is 468 mm. Other orifice heads will give different orifice diameters for the same flow rate.

Structural Design and Construction - Timber Weirs

Introduction

Timber weirs may be used for small structures (less than 1 m crest height and 5 m width). The weirs are formed with hardwood timber sleepers. Horizontal timbers form the weir with vertical timbers providing support. Rock is used to prevent erosion from water cascading over the weir. Geotextile is used to prevent water leakage through any gaps in the timbers and also to prevent soil loss from beneath the rock.

Construction materials

A single weir 3 m wide with a 50 cm drop will require the following: approx 16 hardwood sleepers, approx 8 cubic metres of rock, approx 25 square metres of geotextile. The design and quantities will need adjustment for different sized weirs.

Timber Sleepers: Sleepers come in a range of sizes, such as 2400 x 200 x 100 mm. Durability Class 1 or 2 (e.g. red gum) timber will provide a long life.

Rock: Rock should be large, hard, angular and have a range of sizes from 100 to 600 mm with an average size of at least 300 mm.

Geotextile: Medium weight, non woven, needle punched (e.g. Bidim A44). It is sold at many building materials supply stores.

Other Materials: Galvanised nuts and bolts will be required to assemble the weir. Concrete is used to backfill around the vertical timbers to provide a sound support for the weir.

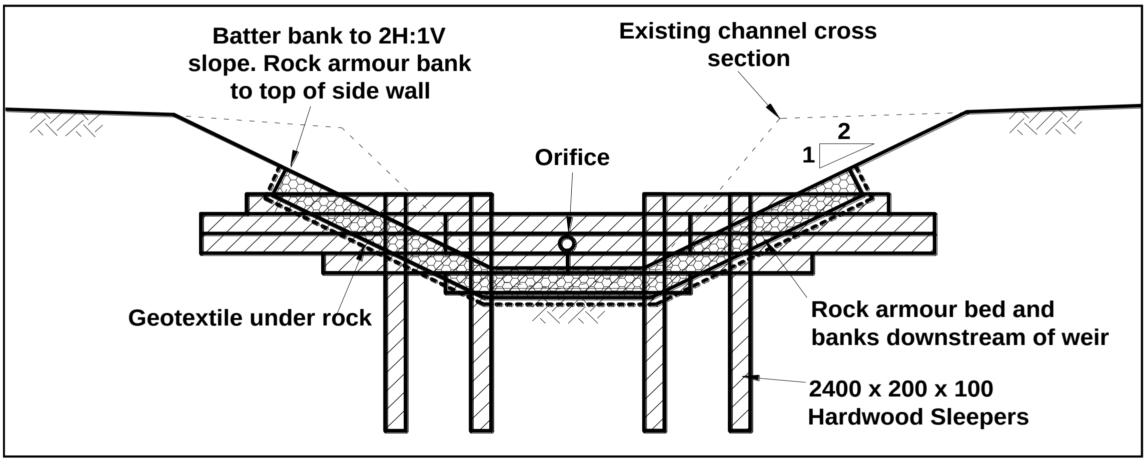


Figure 8: Timber weir, typical cross section view

Construction notes

Step 1 – Set Out: Mark out the location and extent of the weir on the ground. Use survey (dumpy) level to set the crest levels as required.

Step 2 – Excavation: Batter the watercourse banks, excavate the slot for the weir, bore the holes for vertical timbers and excavate the creek bed for rock placement.

Step 3 – Vertical Timbers: Install the vertical timbers in the bore holes and set in place with concrete.

Step 4 – Horizontal Timbers: Fix the horizontal timbers to the vertical timbers. The first timber should be set below creek bed level and timbers should extend at least 1 m into each bank.

Step 5 – Orifice Hole: Cut the orifice hole in the in-stream weir in accordance with the requirements set out on the previous page.

Step 6 – Geotextile: Staple geotextile across the upstream face of the weir (cut a hole for the orifice) and lay geotextile in the area excavated for rock placement. Any joins should overlap a minimum of 50 cm.

Step 7 – Rock Placement: Place rock in the creek bed downstream of the weir for a distance of at least 5 times the crest height. Rock should be a minimum 600 mm thick and be set entirely into the creek bed rather than placed upon it. Rock must extend up the banks to the top of the side wall.

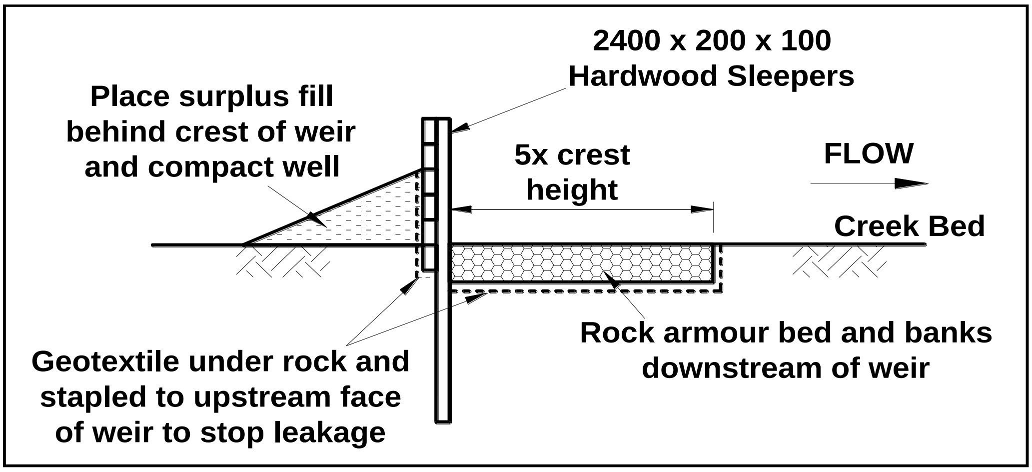


Figure 9: Timber weir, typical profile view

Figure 10: Timber weir, example of a structure

Structural Design and Construction – Concrete Weirs

Introduction

Concrete weirs may be used for structures up to 1 m crest height, 30 cm side wall height (above crest) and 10 m crest width. The concept may be used for larger weirs however the structural details will need reassessment by a qualified engineer.

For reasons of safety (ie potential formwork collapse) and functional requirements (ie prevention of formwork deformation) construction must be undertaken by an experienced builder or contractor.

Construction Materials

Concrete: Concrete must be N32 (32 MPa) with a maximum aggregate size of 20 mm and slump of 80 mm.

Steel Reinforcement: Two types of steel reinforcement are required.

SL.82 reinforcing mesh must be centrally placed in all heel, toe, crest, sidewall, cut-off and abutment walls and slabs.

N12 deformed bars are required in the form of "L-bars" to connect all junctions in the structure (ie at all wall/slab, wall/abutment and slab/cut-off wall junctions). These "l-bars" shall have 400 mm legs and be placed at 400 mm centres along the junctions.

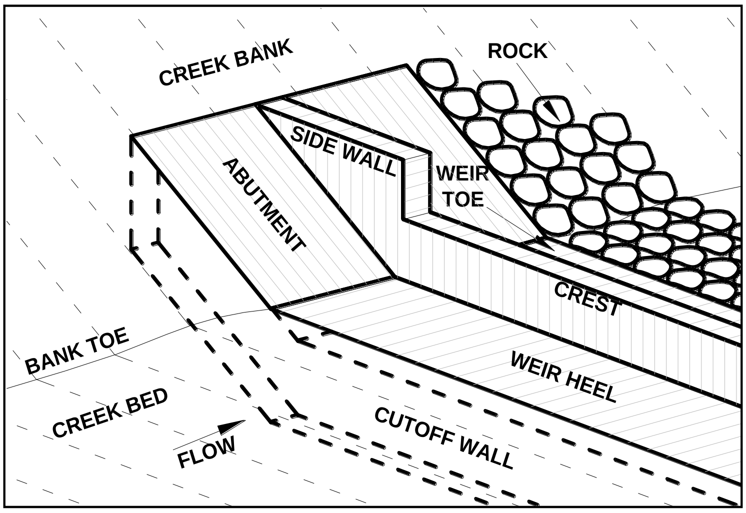


Figure 11: Concrete weir, perspective view (half weir)

Construction notes

Step 1 – Set Out: Mark out the location and extent of the weir on the ground. Use a survey (dumpy) level to ensure that the crest levels of the in-stream and diversion weirs are as required.

Step 2 – Excavation: Batter the watercourse banks and excavate the bed and banks for the weir slab (heel and toe) and abutments. Excavate a trench for the cut-off wall, down to solid impermeable material. The cut-off wall and trench should be a minimum 50cm deep.

Where solid, impermeable material is at considerable depth, alternatives such as steel sheet piling may be used for the cut-off wall. Consult a qualified engineer.

Step 3 – Formwork: For safety as well as functional reasons formwork must be designed and installed by an experienced builder or civil works contractor.

Formwork must be rigid, watertight and constructed to AS3610, S.A.A. Formwork Code.

Step 4 – Reinforcement: Cut and install steel reinforcement mesh, and 'L-bars' in accordance with the drawings.

All reinforcement must be firmly held in its required position and adequately supported by 'chairs' at approximately 750 mm centres.

Reinforcement is to be placed centrally within the walls, slabs and abutments.

Splices in reinforcing mesh, if required, shall be equivalent to the cross-wire spacing plus 25 mm.

Step 5 – Weir Orifice: The weir orifice should be formed within the formwork before the concrete is poured.

For orifice diameters matching standard pipe diameters, the orifice may be formed using rigid pipe fixed and sealed to the concrete forms at the proper location and level. Alternatively steel sheet may be cut, rolled and joined to form a cylinder of the appropriate diameter.

Reinforcing may need to be cut to allow the cylinders to be installed. This pipe or steel cylinder will remain set in the finished concrete weir.

Step 6 - Concrete Placement: Pour concrete to the design levels and compact using a mechanical vibrator to remove all entrained air and completely fill the formwork.

Step 7 - Concrete Curing: Curing must be undertaken in accordance with AS3600, S.A.A. Concrete Structures Code. All exposed surfaces of the concrete must be kept moist be application of either a curing compound or by covering with polyethylene sheeting for at least 7 days.

STRUCTURAL DESIGN AND CONSTRUCTION – CONCRETE WEIRS

Figure 12: Concrete Weir, Profile View

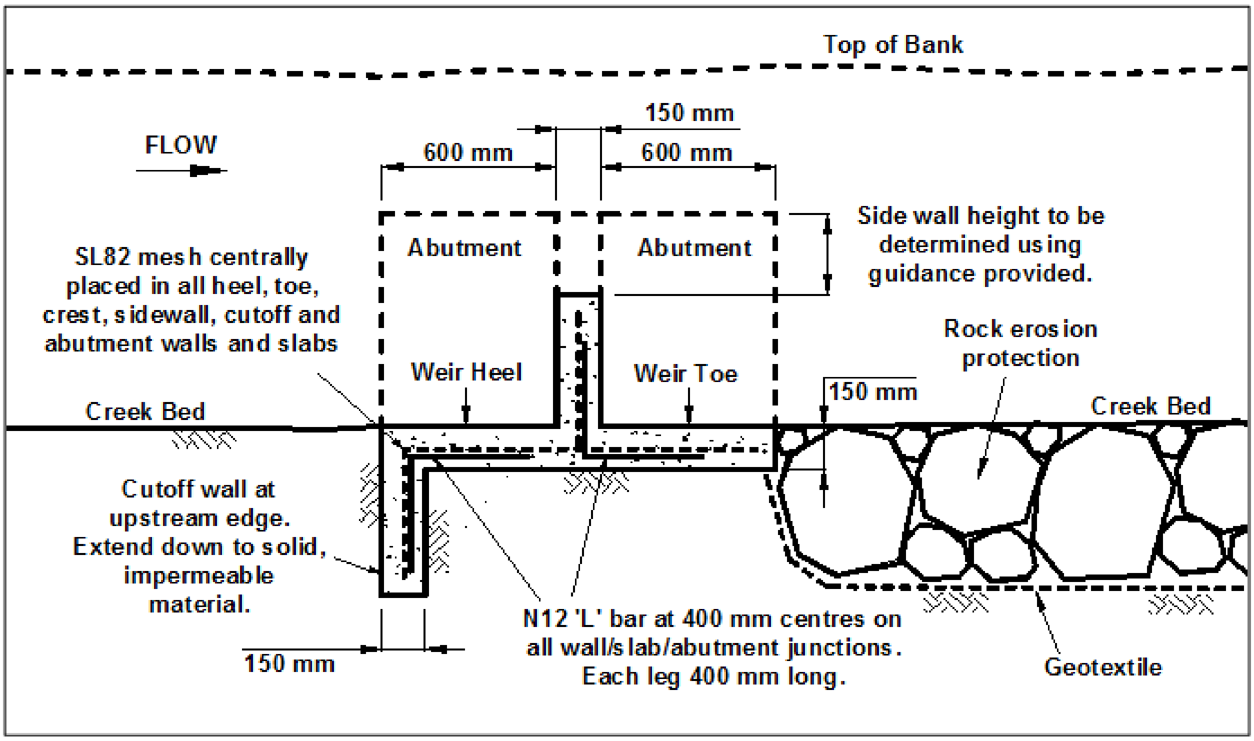
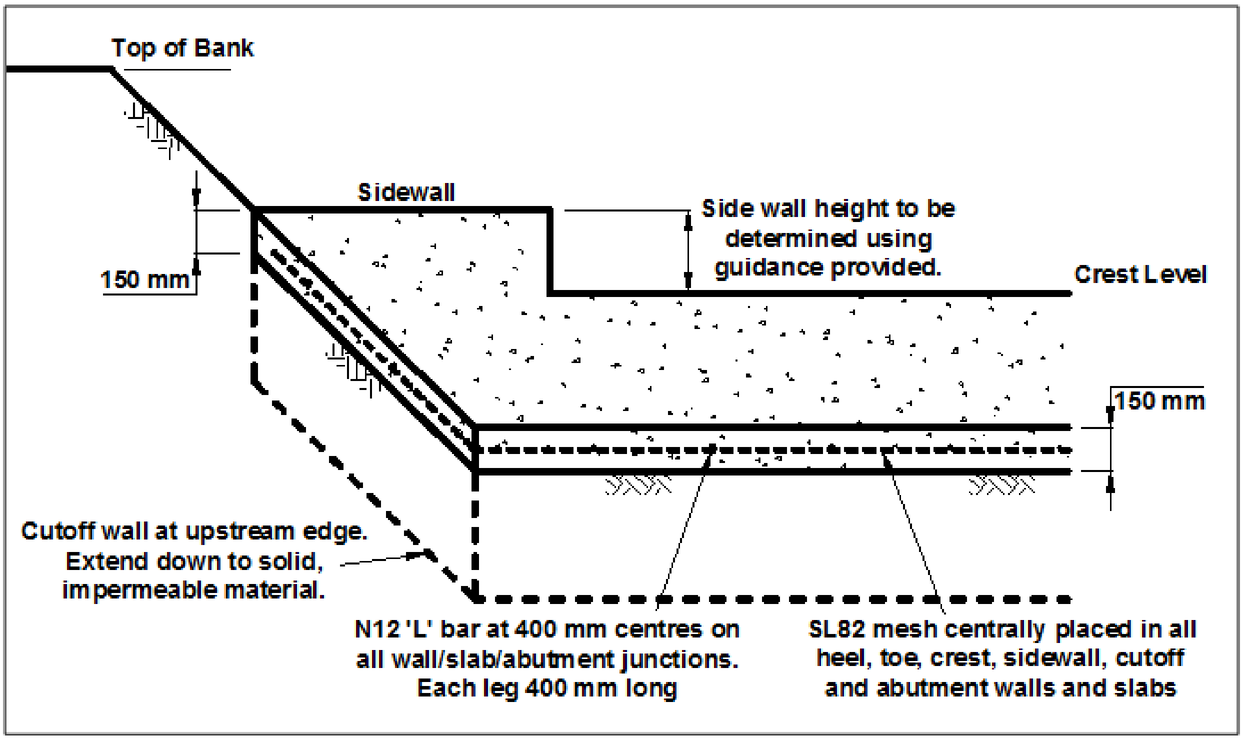


Figure 13: concrete Weir, Cross Section (half weir)



More information

Water Planning and Assessment Officer
Phone: 0448 699 514

www.landscape.sa.gov.au/mr/water/managing-water-resources/water-affecting-activities