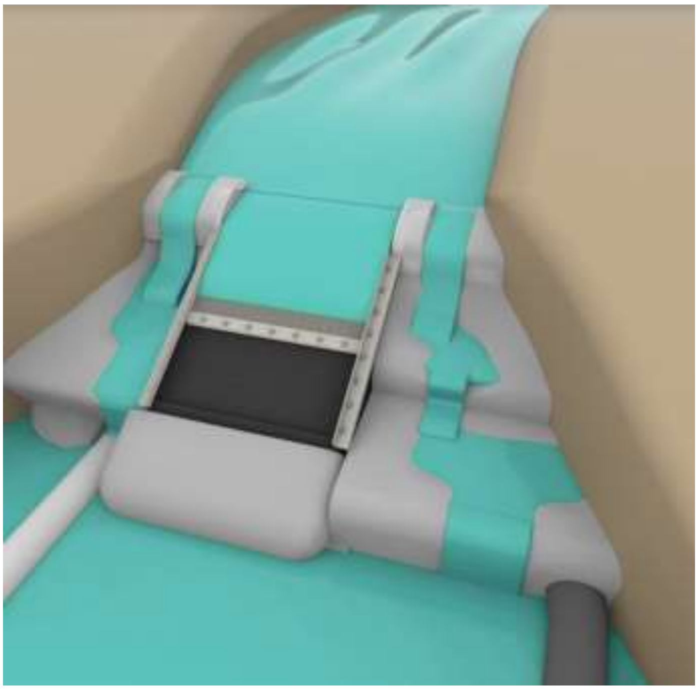
PowerSpout Coanda Intake Screen
(referred to as Coanda)
Specification & Installation Manual



Coanda Intake

Cube turbine
(in same case)

Shipped together

PowerSpout is a product proudly designed and manufactured by:

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Edition
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CONTENTS

1. Introduction

1.1. This manual and other information sources

We offer a wide range of other free documents in pdf format, and some videos. All relevant manuals are considered to be part of the product. Have a look at our Document Index for further reading and videos on specific topics relevant to your situation.

1.1.1. The scope of this manual

The purpose of this Coanda guide is to provide detailed information and installation instructions for the Coanda screen that we manufacture and can supply at the same time as your PowerSpout turbine.

1.1.2. When planning your system, please read:

- Site assessment guide
- Intake guide and Coanda intake guide (this document)
- Pipe selection guide
- Manifold guide
- Hydro design and calculator manual

You can estimate your site's generation potential and even design the whole system painlessly using our online Advanced Calculator Tool. To get the best out of it please read the Hydro design and calculator manual first.

1.1.3. When installing an off-grid system, please read:

- Power conversion equipment guide
- Battery guide
- Charge controller guide
- System wiring guide
- Powershed design guide
- Diversion load guide

1.1.4. When installing and commissioning your turbine, please read:

- Cube installation guide
- PLT installation guide
- TRG installation

1.1.5. When operating and maintaining your PowerSpout turbine, please read:

- Your log book
- Bearing care guide

Our worldwide network of dealers can also help you with system design and choosing the best equipment for your situation.

1.2. Product scope and specification

1.2.1. Scope of application

All PowerSpout hydro turbines require an intake screen to filter solid matter out of the water. For a detailed intake screen guide click here.

The PowerSpout Coanda intake screen removes rubbish, stones, leafs and aquatic life forms from the flow prior to entering the supply pipe (penstock). This is often a requirement of environmental protection agencies. A poor intake is normally the cause of most hydro turbine system problems. Poor intakes may allow small stones to enter the penstock that can cause serious damage to the Pelton rotor or cause the jets to suddenly block resulting in severe water hammer that can rupture pipe and fittings.

Our Coanda intake screen is not limited to small hydro schemes, it can also be used for domestic, farm, village and small town water supplies.

1.3. The installer must:

- Check for any transit damage to the product prior to installing it. If damaged it must not be installed. If the Coanda screen is being freighted on to the end client then you must check it prior to this next freight leg.
- Connect this Coanda intake screen in compliance with this guide and site conditions. If the site is prone to rock falls, slips and severe floods then seek local engineering advice prior to purchase or accept this risk yourself.
- When assembling the screen make sure the Coanda screen is in the correct orientation (or it will not work). This is detailed later in this guide.
- Read and comply with this installation manual.

1.4. Safety

The following safety warning signs are used throughout this manual.

Caution
Cautions identify condition or practices that could result in damage to equipment or personal injury.

This section addresses safety concerns as required for best practice documentation.
If you are not practically experienced you should not install this equipment alone and should engage the services of a suitably trained person.

Intakes for remote hydro schemes are often in very remote locations in steep sided valleys where cell phones tend not to work and your voice may not carry far due to the heavy vegetation cover. Sensible precautions are outlined below.

1.4.1. <u>Working in remote locations</u>

When working in a remote location avoid working alone. If you do need to do so, make sure another person has been advised of where you are and when to expect you back.

1.4.2. <u>Fall hazards</u>

Penstocks (pipelines) are often routed through steep locations with various hazards including danger of falling from heights, or rocks etc falling from above. Take care to prepare suitable access to the site and install safety ropes, steps, etc.
Be aware that helpers may dislodge rocks that can fall onto persons working below. Assess the risks and take precautions to reduce such hazards.

1.4.3. <u>Suction hazards</u>

When installing a penstock that could be completely covered by a person (small or large, young or old), be aware that suction hazards can exist if certain precautions are not taken. A long pipe may have many tonnes of water on the move. In the event that a person (intentionally or unintentionally) blocks the intake of a hydro system, they can be exposed to large amounts of negative pressure. This suction force can hold a person against the intake with such magnitude that the person is unable to free themselves, not even with the help of bystanders. As a result severe internal injuries and death can occur. Read more on this topic here.

These are the minimum precautions you must take to avoid such suction hazards:

- Do not operate a hydro penstock without an intake screen securely installed.
- As soon as possible after the intake, install a vertical vent pipe that will break the suction in the event of an intake blockage. This is the same vent needed to vent trapped air, more on this topic later.
- Erect a sign at the intake warning people of the hazard.

1.4.4. Over exertion hazards

Hauling cement and tools up steep river valleys is physically demanding work. Limit loads per person to 20kg and let fit younger helpers do most of the heavy hauling work. Ensure at least one person in the install team has a current 1st aid certificate and is carrying an appropriate 1st aid kit.

1.4.5. Flash flooding hazards

An intake may take several days to complete. Keep an eye on the weather and leave the steep river valley at the 1st sign of heavy rain.

1.4.6. Installation and maintenance hazards

Polyethylene pipe can be hazardous when uncoiling. The pipe behaves like a spring that can recoil with surprising violence and cause injury. Take care when releasing the binding from coils of pipe. Take care when straightening pipes that they do not spring back and hit somebody. Give the pipe time to change shape. Warmer temperatures speed this process up.

1.4.7. General safety

Conduct a site-specific risk assessment. In addition to all the above you should:

- wear gloves when handling screens as they may have sharp edges
- wear eye and ear protection when drilling holes in rocks
- if using a portable generator set for electrical power at the intake site use an RCD for protection from accidental electrocution

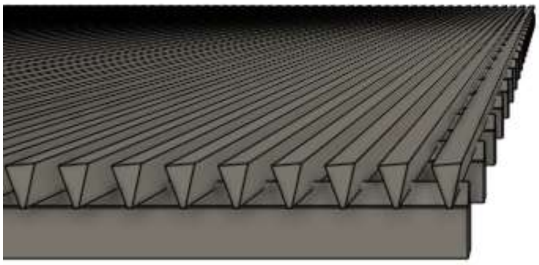
2. Your Coanda Intake Screen

2.1. Introduction

The PowerSpout Coanda Screen is our new cost effective intake product that ships for free (in most cases) when purchased with one our; PLT, Cube or TRG turbines in the same DHL carton.

Our Coanda intake screens are designed to provide low maintenance screening solutions for water intakes without the need for any moving parts. The self-cleaning ability and high abstraction flow capacity is due to the shape of the screen and the arrangement of the wedge wires that make up the screen.

The Coanda screen uses the **Coanda effect,** which is the phenomena in which a jet flow attaches itself to a solid surface and remains attached, even when the surface curves away from the initial jet direction.



The screen is built from wedge-shaped wires that have suitably angled faces to which the flow attaches.

Water is directed over the screen in a fast-moving sheet, and the bars deflect it into a tank below whilst debris continues straight on and is washed off by the surplus flow.

Water and some fine silt particles (<1.5mm) pass through the screen, whilst larger silt and debris is excluded and deposited downstream. During times of low river flow the screen capacity may be greater than the available water. Under these conditions debris can build up on the lower parts of the screen. This will be washed off the next time the river flow rises above the screen capacity.

2.2. Advantages of the Powerspout Coanda products

There are several companies that make such screens globally, but they are costly to buy and freight. We decided to make our own to overcome the following issues:

- High purchase cost. We reduce the cost by sharing a casing design with our Cube (hydro turbine) and SHP-triplex (solar water pump)
- High freight cost. We have designed the casing so that it is the shipping container.
- We provide installers with an off-the-shelf solution at a lower cost than they can import from another manufacturer.

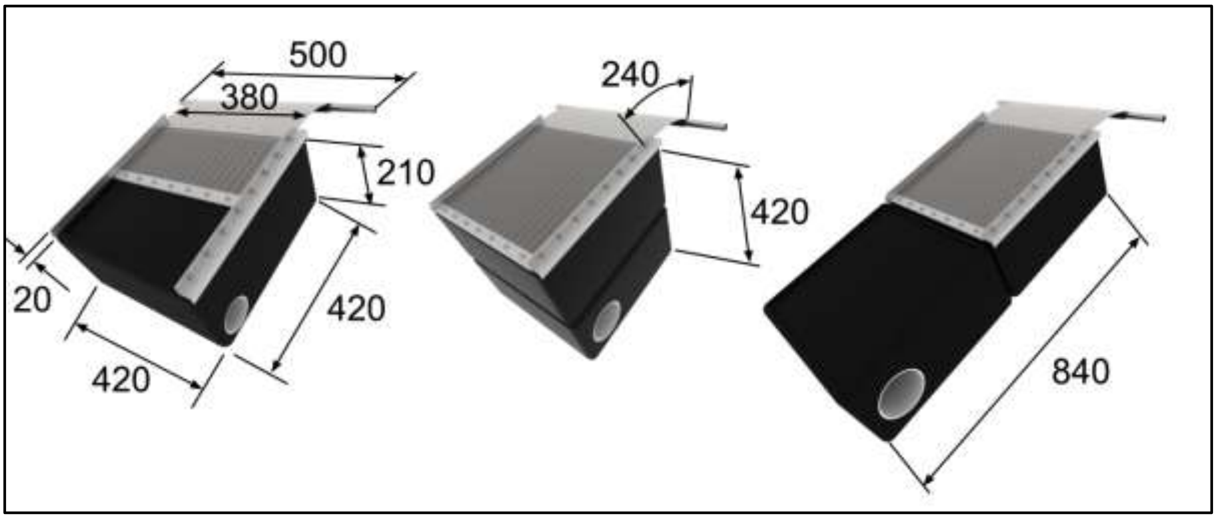
We appreciate that there will always be clients who cannot afford to buy a complete Coanda screen assembly from us. In these cases you can buy just the Coanda screen insert and make your own, following the same general guidance in this document. This screen insert can be shipped along with a Cube DIY hydro turbine kit. This enables clients in developing markets to generate power from hydro at the lowest cost possible.

All our full screens can be parallel stacked to make larger screens for those installing large village sized hydroelectric plants in combination with many of our hydro turbines (also parallel stacked).

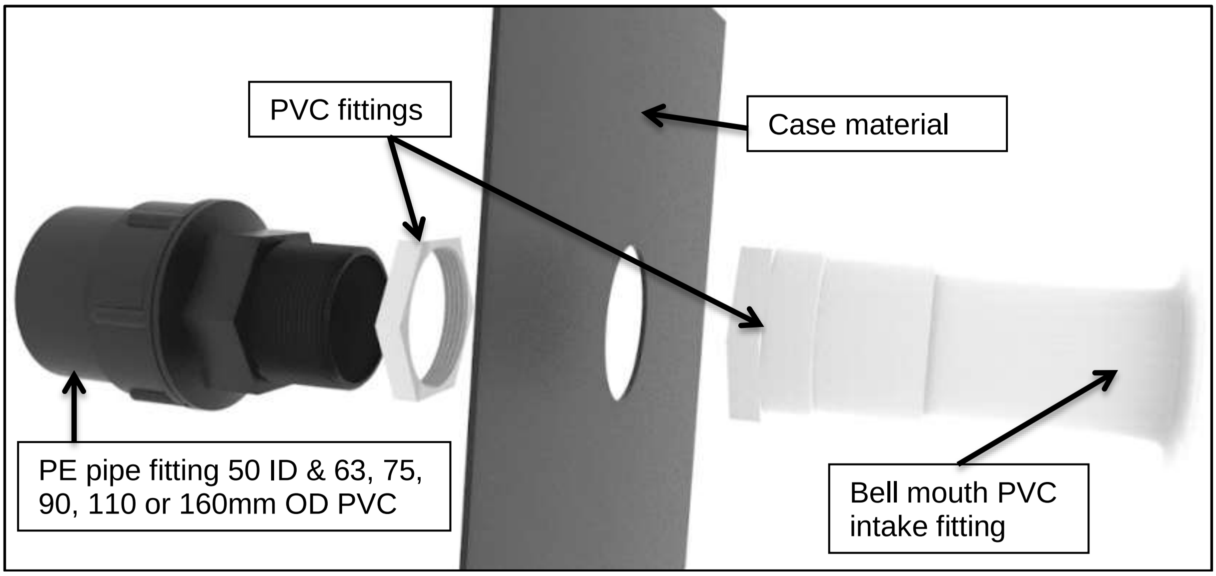
2.3. Complete Coanda intakes - the 3 basic options

½ Coanda Cube Coanda Rectangle Coanda

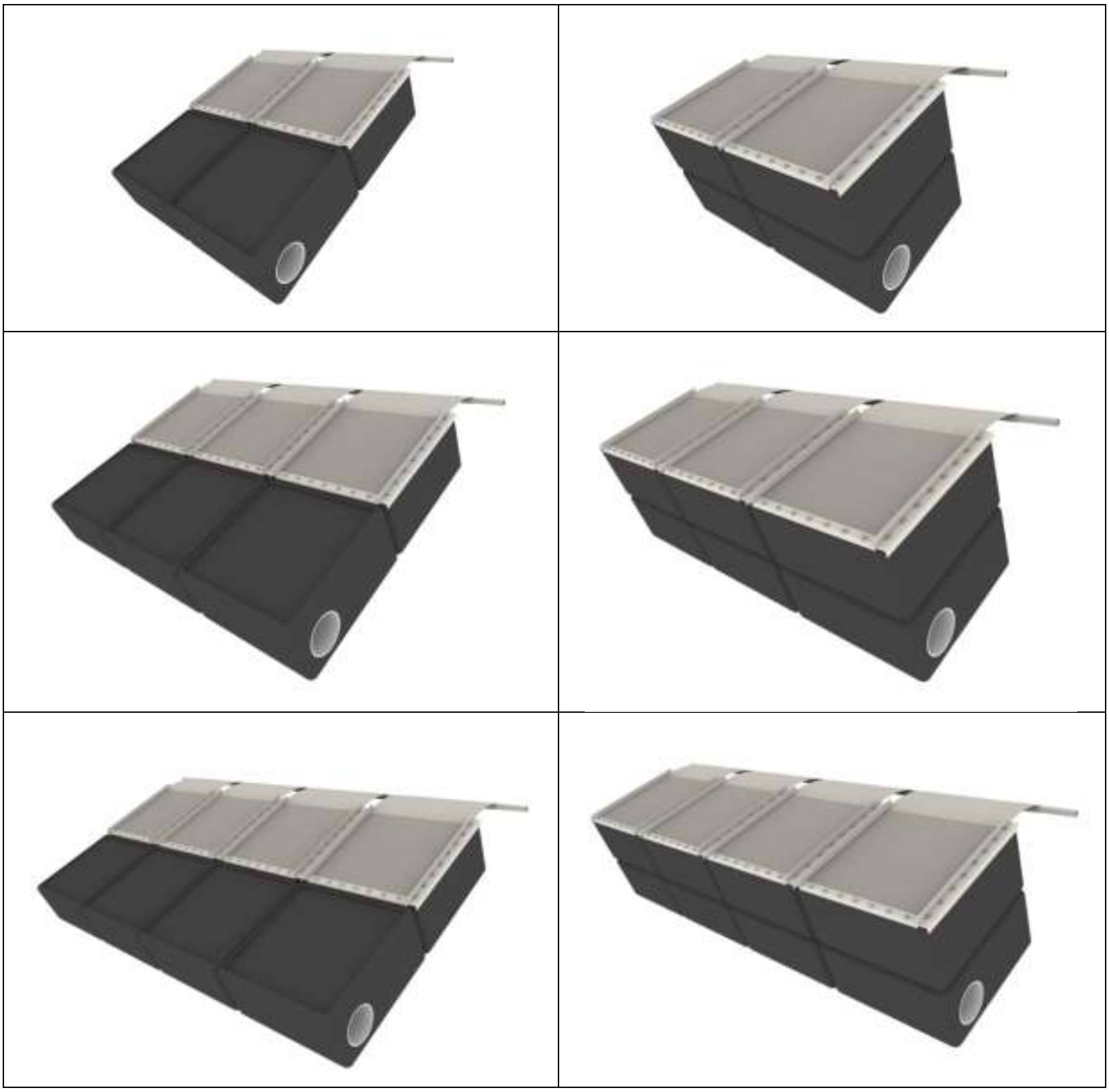
2.3.1. Dimensions in mm



2.3.2. Standard options for pipe fittings



2.4. Common stacked configurations



2.4.1. Fittings on stacked assemblies

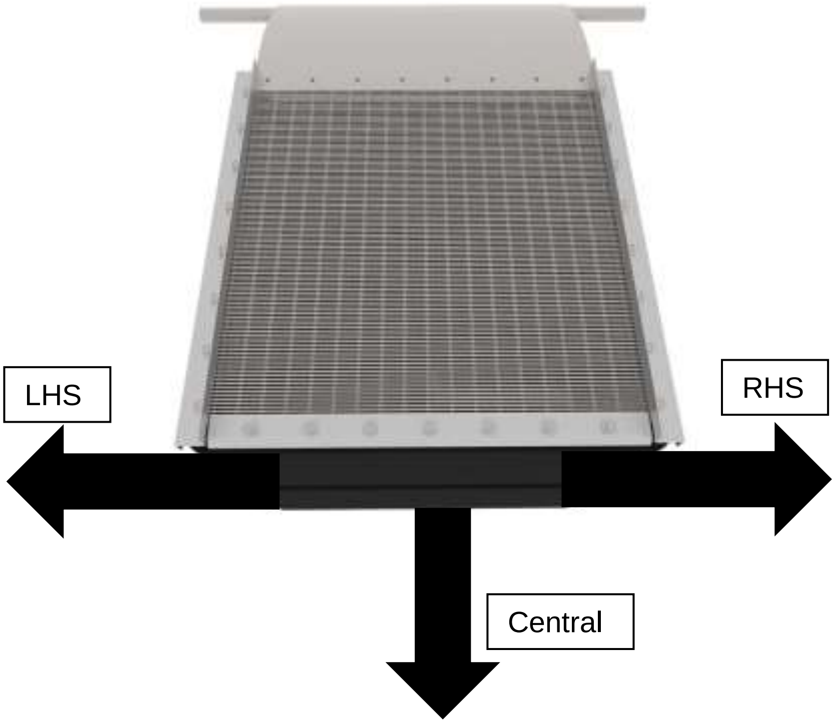
Any intakes ordered for 2, 3 & 4 units side-by-side (as above) are supplied with 160mm OD PVC (150mm ID) pipe fitting on both the LHS and RHS. Both these takeoffs must be connected to your turbine(s) supply pipe (penstock).

For intakes larger than 4 stacked screens we suggest you buy our screen inserts and make you own tank and pipework to suit your site.

2.5. Connection options Pipe fitting to be on which side?

You can order your intake so that the pipe can attach on the left hand side LHS, right hand side RHS or in the central location as shown below.

You should avoid (if possible) a sharp elbow connection to the intake casing. Once the pipe is connected to the intake it can be concreted over (to help protect from floods), as it is very unlikely you will ever need to separate the intake tank from the pipe again.



The central option is possible but not advised, unless there is no space for a LHS or RHS fitting.

2.6. DIY options

DIY Screen

DIY ½ Screen

DIY complete kit - all parts except black casing
We will likely offer DIY bundles such as:

- DIY Coanda screen kit
- DIY Cube turbine
- DIY Cube manifold kit

For those who want to better understand the differences between the Cube and the PLT and how they can freight with our Coanda screens click here.

All DIY screens will have this option:

- Acceleration plate, retaining tube and aluminium trim
- Fitting size in the range: not supplied, 50mm ID, 63mm OD, 75mm OD, 110mm OD, 160mm

Note. All DIY clients (who decide to make their own intake using some of our parts) are assumed to be practically capable and have the required tools, if support is needed this is via a paid support ticket.

2.7. Product selection using the nominal flow rating table

Theoretical flow (in new clean condition) 34 l/s

Approved nominal flow, allowing for some fouling, wedge-wire wear and sub optimal installation 17l/s

Use our online calculation tools to determine your site flow etc.

	½ Screen	Full Screen	2 x Full Screen	3 x Full Screen	4 x Full Screen	Build your own with our screen inserts
Approved flow l/s	8	17	34	51	68	>68
Use with turbine	PLT Cube	PLT(s) Cube(s) TRG	PLT(s) Cube (s) TRG (s) LH-mini	PLT(s) Cube(s) TRG(s) LH-mini LH	PLT(s) Cube(s) TRG(s) LH-mini(s) LH	PLT(s) Cube(s) TRG(s) LH-mini(s) LH (s)

For example (click the blue headers to see an example calculation for each scenario):

Very high head 160m
: 3 x PLT turbines can do 3.6kW with a flow of 6.4 l/s and will require ½ Screen to be installed.

High head 130m
: 6 x PLT HP turbines can do 9.5kW with a flow of 15.5 l/s and will require 1 x Full Screen to be installed.

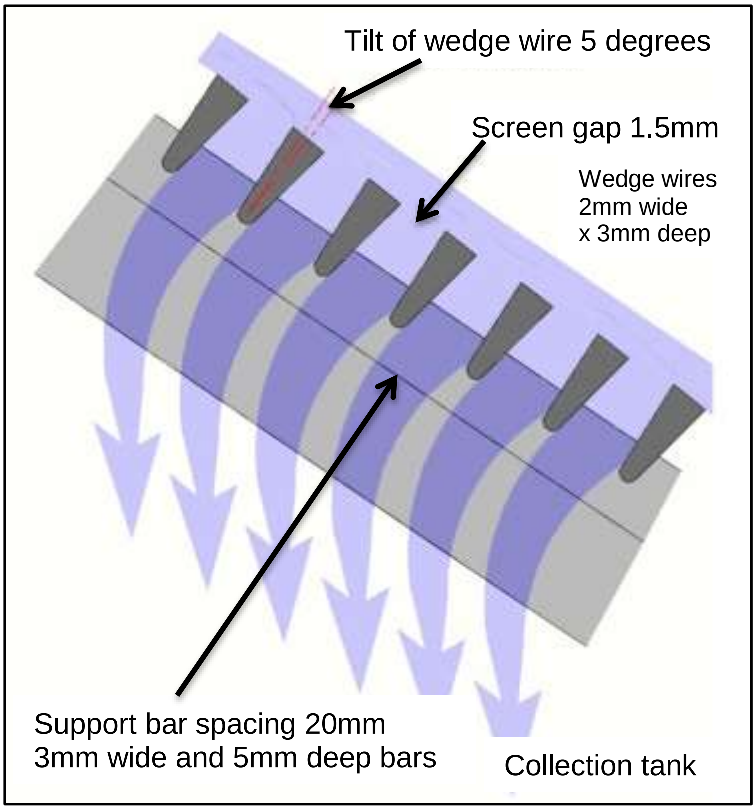
Medium head 50m
: 4 x Cube turbines can do 3.5kW with a flow of 13.8 l/s and will require 1 x Full Screen to be installed.

Medium-Low head 30m
: 6 x TRG turbines can do 10kW with a flow of 68 l/s and will require 4 x Full Screens to be installed.

Low head 5m
: 1 x LH turbine can do 1.5kW with a flow of 55 l/s and will require 4 x Full Screens to be installed.

Very Low head 2m
: 1 x LH-mini can do 0.2kW with a flow of 20 l/s and will require 2 x Full Screens to be installed.

2.8. Screen specifications



Material:	304 stainless steel
Screen gap:	1.5mm
Wedge wire tilt angle:	5 degrees
Wedge wire width:	2mm
Wedge wire depth:	3mm
Supporting bar:	3mm wide x 5mm deep at 20mm spacing
Width x length:	380mm x 380mm (half screen 380mm x 188mm)
Effective width installed:	360mm
Length ½ Screen installed:	168mm
Length Full Screen installed:	360mm
Screen angle relative to flow rate:	0 to 40 degrees (we recommend 25-35 degrees)
Approved nominal flow (full screen)	17l/s
Rated load:	A person of 100kg can stand on the screen without damage.

2.8.1. Wedge wire tilt angle

The 5 degree wedge wire tilt angle was determined from a theoretical model, as you can see from the results table below, a 360x360mm, 5 degree tilt angle can flow 30l/s (0.03m^3), this is 100% more than the same screen area with a 0 degree tilt angle. Larger tilt angles of up to 10 degrees increase the flow by another 30% but are more likely to snag debris flowing over them.

Inflow = 0,03 m^3/s			
Screen Slot size (mm)	Porosity =slot/(slot+wire)	Screen Wire Tilt Angle (°)	Screen size (m)
1,5	0,396	0	0,51 x 0,51
		5	0,36 x 0,36
		10	0,32 x 0,32

2.8.2. Screen inclination

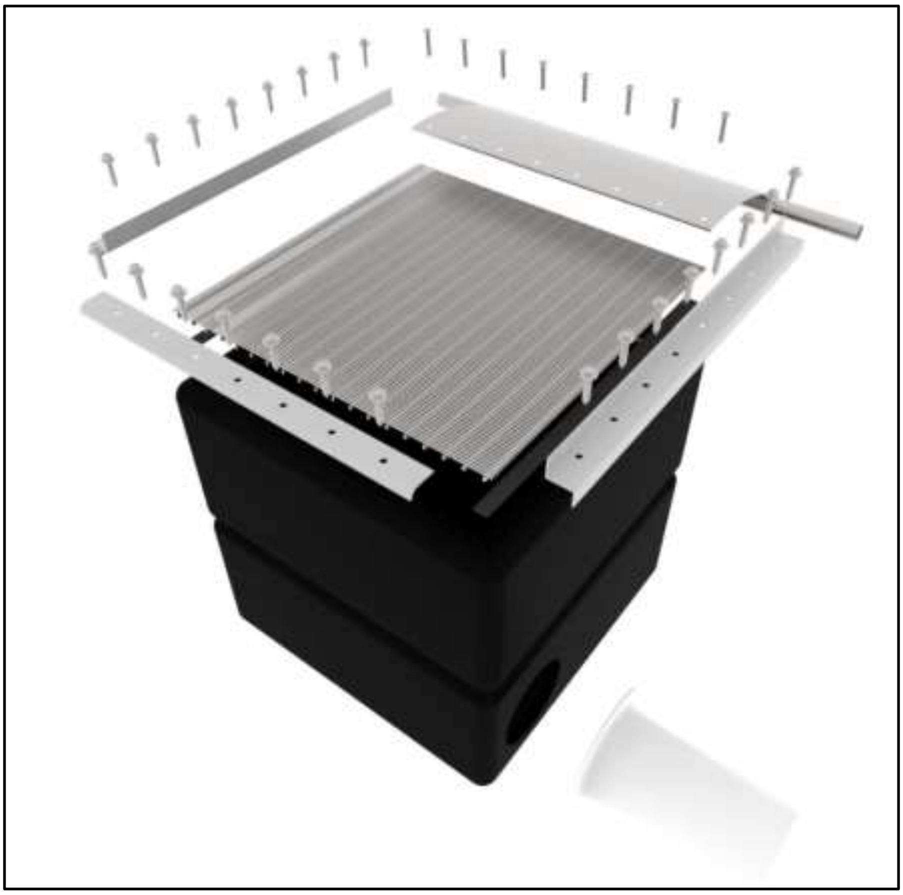
A theoretical model of the effect of screen inclination showed that the optimal inclination from the horizontal is between 10 and 40 degrees. Even horizontal screen performance is 95% of optimal. Inclination should not ever exceed 45 degrees. Our advice for best flow performance is 30 degrees. Our advice for best debris removal is 40 degrees.

3. Parts, functions and assembly

Congratulations on your choice of a PowerSpout Coanda Screen. This ingenious intake will give you years of trouble free screening.

This section is a guide to the parts of the intake assemblies and what is supplied.

Your screen will arrive disassembled for freight. You will therefore need to assemble the screen following the instructions later in this document. This should take no more than 10 minutes to do per screen ordered.



Each complete screen comes with:

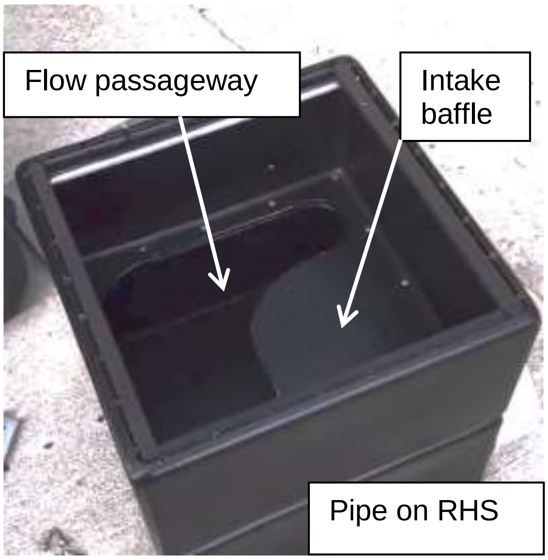
- Black roto-molded LDPE casing
- Coanda screen (**note:** Due to welding stress, the stainless steel Coanda screen insert is not flat. It becomes flat once installed correctly – orientation is critically important)
- Outlet pipe fitting based on your selected size option
- Acceleration plate and securing tube
- Low entry-loss (bell-mouthed) internal fitting
- Vortex breaker plate
- Securing anchors so it can be concreted into position

3.1. Internal baffles

In any intake where the pipe mouth is close to the water surface, there is a possibility that vortices will form that bring air down into the flow. A baffle close to the surface can help to prevent this happening.

3.2. Internal baffle (Cube Coanda)

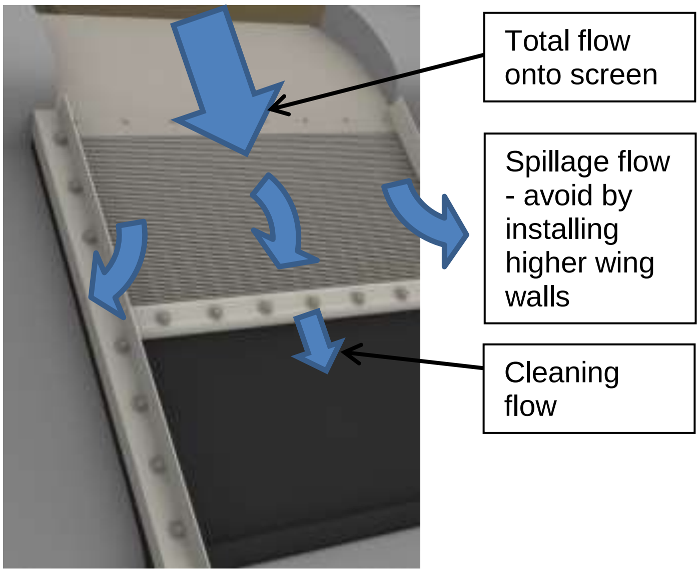
The shape of the internal baffle (that helps to prevent the establishment of a vortex) depends on which side the pipe fitting is to be attached. If you decide to change the side of the fitting then you will have to patch and re-cut the internal flow passageway.



3.3. Internal baffle (1/2 and Rectangle Coanda)

For these shallower intake options the baffle is made from a 90-degree internal return centrally located. The baffle has the same location regardless of the pipe fitting location: LHS, RHS or central.

3.4. Wing wall extensions

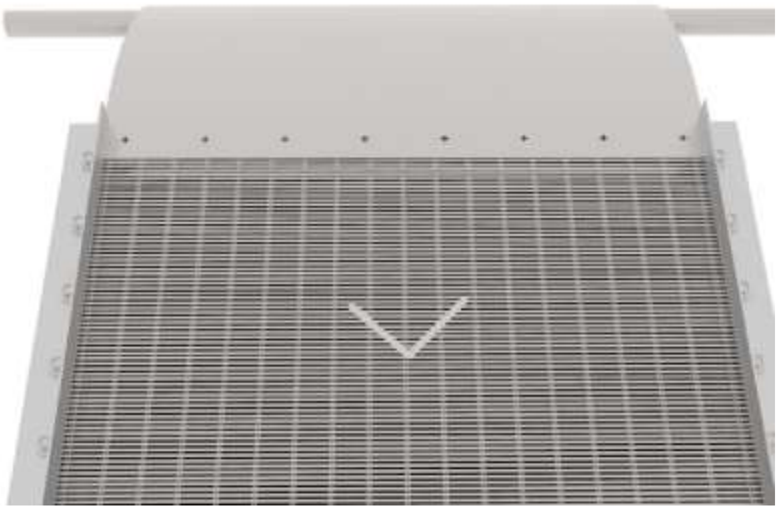


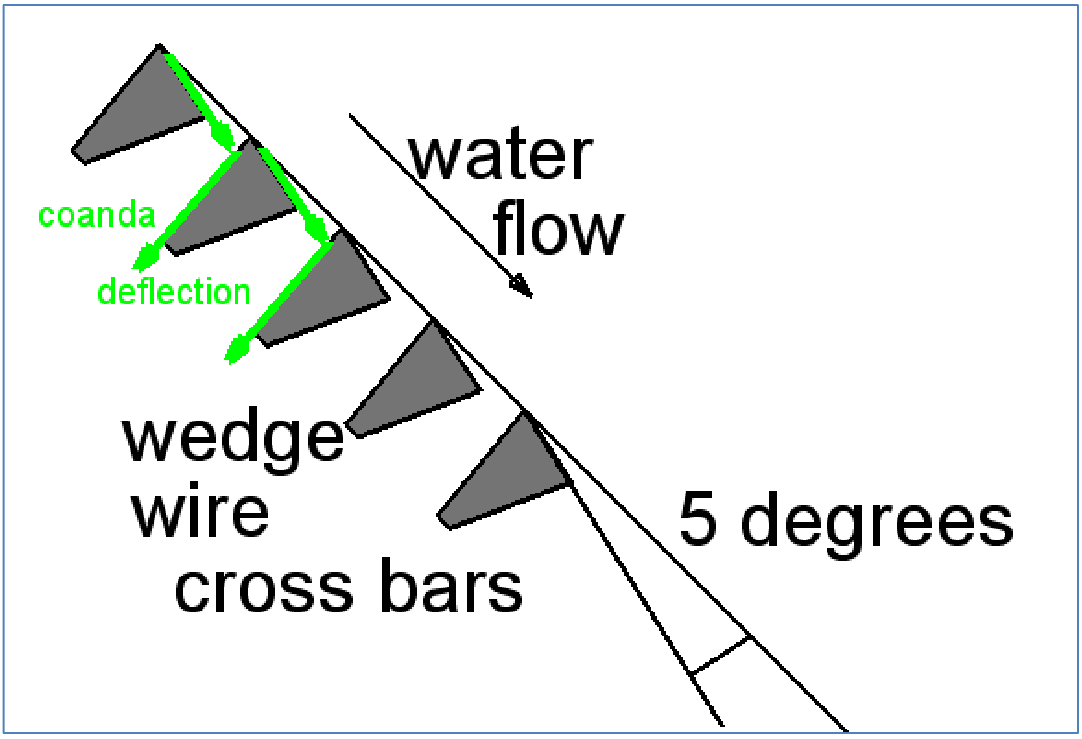
Depending on your site and the number of screens installed you may need to add wing wall extensions to prevent spillage flow. Wing wall extensions may not be needed on ½ Coanda screens but may be needed on full and parallel-stacked Coanda screens.
Such extensions are an optional extra that can be ordered if required. They are easy to make locally from 2-3mm thick aluminum flat bar.

3.5. Screen orientation

The most common mistake is to install the screen the wrong way around.
An arrow **>** is engraved in the center of the screen to indicate the correct flow direction.

The 5-degree wedge wire tilt angle is not easy to spot by eye. This tilt works like a cheese grater, slicing a layer of water and directing it into the collection chamber below.



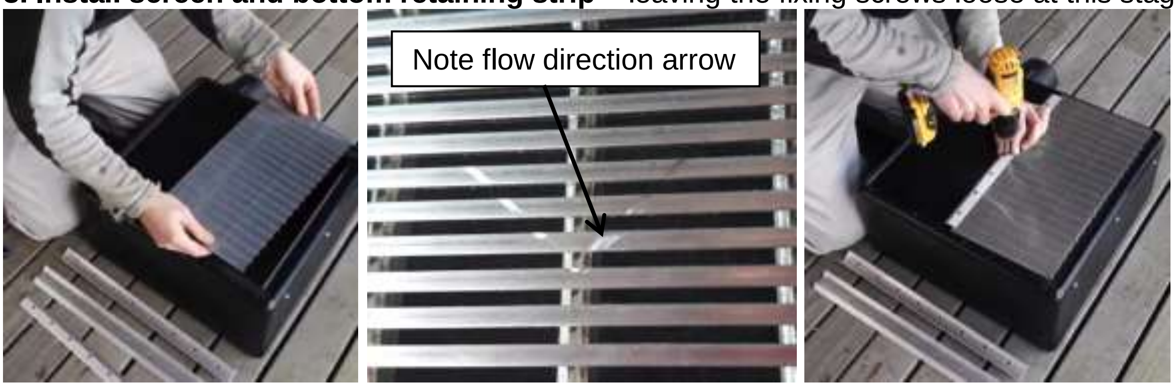


3.6. Assembling a Coanda intake takes less than 10 minutes work

1. Install your pipe fitting (LHS illustrated)
- The bell nosed intake helps to reduce intake friction loss

2. Install baffle (helps to prevent any vortex from forming)

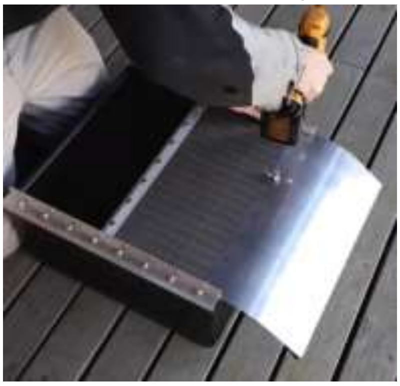
3. Install screen and bottom retaining strip – leaving the fixing screws loose at this stage



4. Install acceleration plate –and then tighten all fixings



5. Install side guide vanes
which help to keep water on screen. Extensions may be needed if water overflows.

6. Install retaining tube for acceleration plate


3.7. Video help

You may find these videos helpful

- Assemble Coanda half screen
- Cube Coanda strip down

4. Installation

4.1. Intake site selection

Before you can install the intake you need to identify the best place for the installation. Every hydro resource will have several potential intake sites. Consider them all to ensure you locate the best one. These are features of the better intake sites:

- At the top of small steep rapids so that a good pipe fall (steeper slope) can be obtained below the intake. You will want to lead the pipe away from exposure to flood water damage (out of the stream path) and this can mean rather a shallow pipe gradient unless the stream is steep. A decent initial pipe fall will give fewer issues with air locks - a potential problem for sites of initial shallow pipe fall.
- On the downstream side of a small manmade weir.
- On the outlet of an existing road culvert. Make sure that the flow is directed along the screen and not pouring down onto it from above though.
- In a wide part of the river so as not to be exposed to excessive flood heights. If the flood height at your intake exceeds one metre, seek professional engineering advice.
- Where you can find a secure foundation. Look for a location where you can anchor to large rocks that have never moved in floods. Such rocks can provide a robust foundation to secure the intake to.
- Where you have good safe access (or it can be made safe). You do not want to be climbing up/down step drops every time you want to access the intake.
- An intake site that is unlikely to suffer from slips, rock and tree falls.
- An intake location that maximizes the head of on your site. For example if you have 2 perfect intake sites always opt for the one at the higher location. Unless at the higher location there is significantly less flow or you exceed pipe/turbine pressure rating.

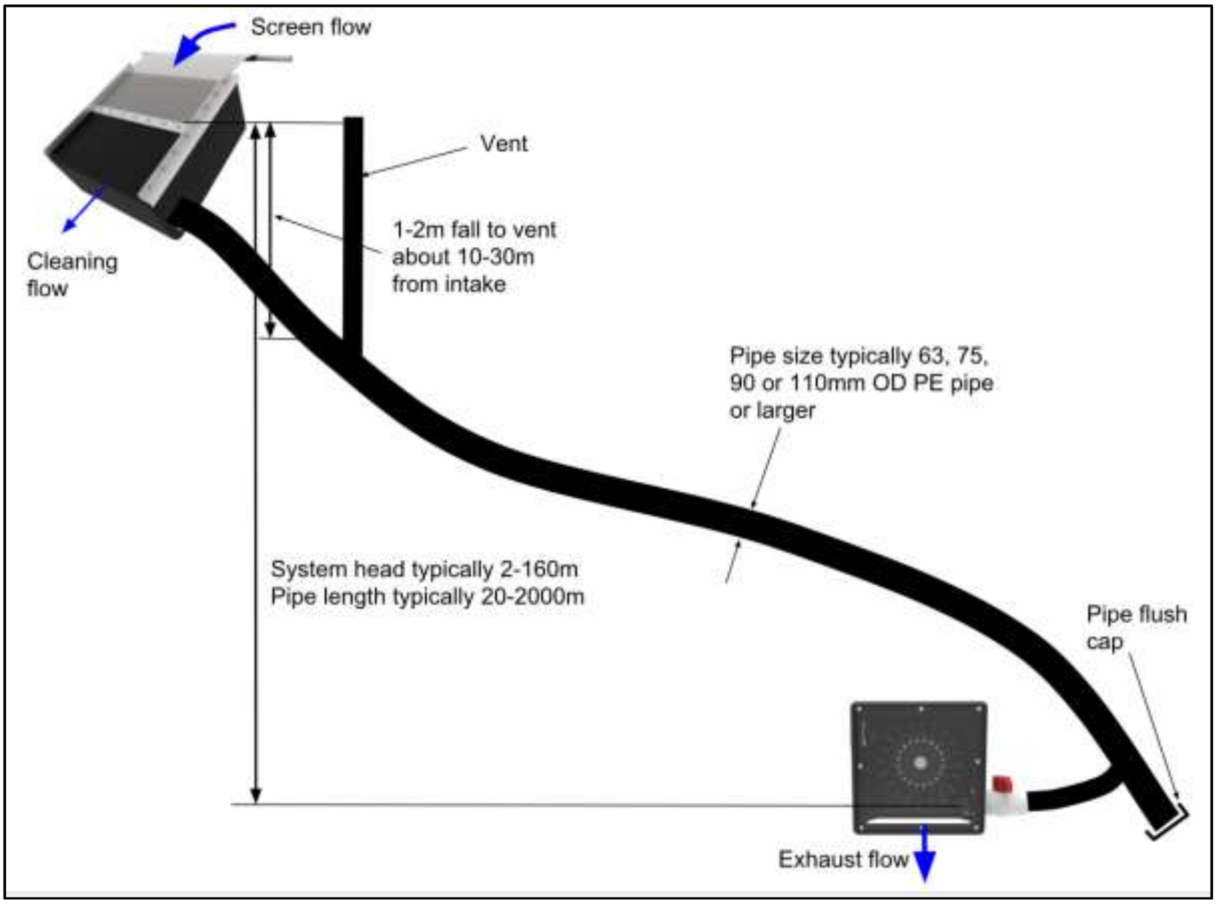
You may not have any perfect intake sites, you are attempting to locate the best site from the options you have. Final selection will often be a compromise.

The screen is strong enough to cope with the static pressure exerted by most flood flows. However, during high flows the water will tend to suck the screens outwards, rather than to push it in. The concrete and fixings used to secure the structure need to be sufficiently strong to cope with this uplift force. If the site is subject to extreme flood flows with movement of large boulders then installation of the screen out of the main river flow is recommended.

4.2. Vents

It's a good idea to fit a vertical vent pipe, branching off the main supply pipe close to the intake of your small hydro plant. This vent serves 2 main purposes:

- Allows air to come out. Provides an escape route for bubbles that were entrained in the intake flow to vent to atmosphere. Otherwise air can accumulate at shallow grades or high points and form a partial blockage to flow.
- Allows air to enter. Acts as safety break to limit high suction forces in the event that the intake (intentionally or unintentionally) gets blocked. For example if the screen were completely covered in impervious material, the suction could damage it.

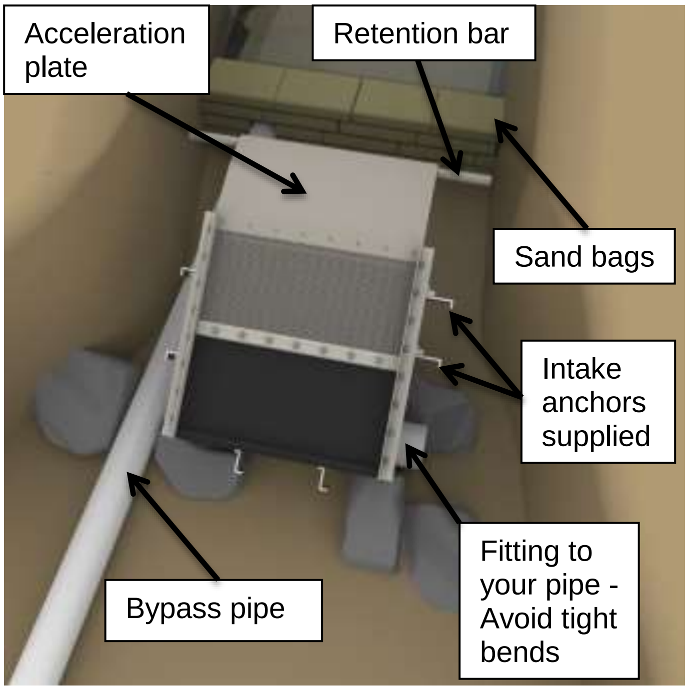


Although this vent is designed to let air out, a badly set up vent can actually draw air in. So be sure that there is sufficient pipe gradient between the intake and the place where the vent Tee is inserted. Friction losses in the pipe entrance, any bends and even the pipe itself might otherwise create a negative pressure at this Tee point which results in air being drawn into the pipe rather than allowed to escape. If the initial gradient is similar to the average gradient of the pipe run, then you should be safe in this respect.

4.3. On-site installation of the intake

Once you have identified a suitable site……….. the hard work begins. We suggest that you build a weir in the path of the waterway. This is best done during a time of low flow.

The initial stage of all intake preparation jobs is to sand -bag the working area to divert the stream flow around or under (via a pipe) to provide a relatively dry working area. With luck there will be sand and small stones in the riverbed you can have harvest to make sandbags and for mixing with cement to make concrete. Where such materials have to be carried in then use builders mix in the sand bags to divert the flow. You can then consume this material progressively over a few days to concrete in the intake, thus reducing the amount of heavy hauling needed to complete the work.



Once you have set up a temporary bypass flow you will need to remove all loose material from the riverbed. With luck (small stones and gravel rather than mud) this can be used to make the concrete.

You want your intake structure to stay in place against the worse flood event, but you must not make a barrier to natural fish passage. Observe the height of typical natural barriers in the river and do not exceed the height of these with your concrete structure. Aquatic life in the catchment will be able to cope with such barriers.

To ensure good adhesion of the intake into the bed of the stream here are some tips:

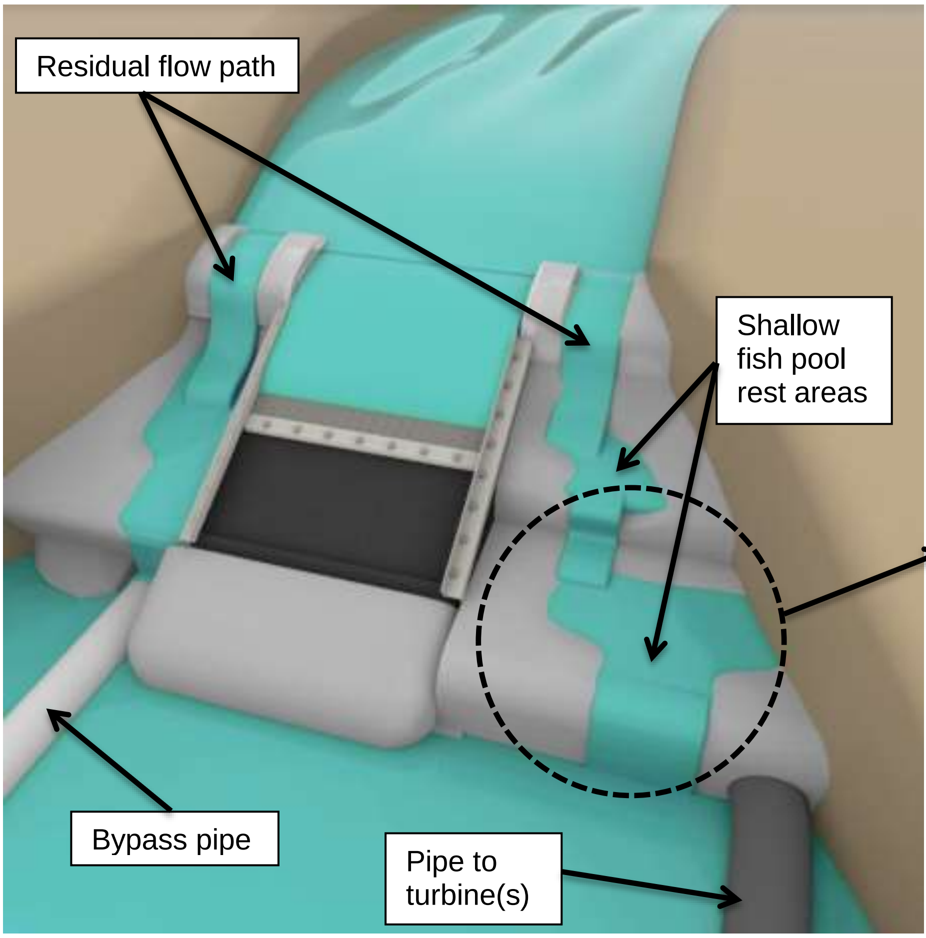
- Dyna bolt heavy steel chain to large rocks under and adjacent to your intake location that the concrete can key to.
- Drive in heavy steel pegs if there are no suitable anchor rocks.
- Attempt to key the concrete to rocks as best you can.

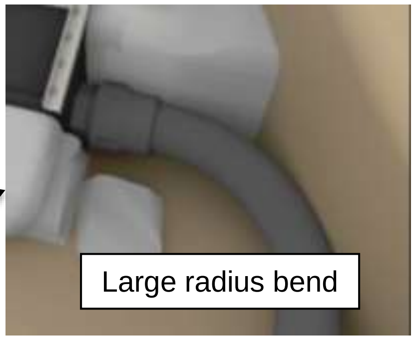
4.3.1. 1st concrete pour

The first concrete pour is to secure/seal the bypass pipe, and to make a good seal with the bed of the river. You need to prevent water from working its way under your construction. Make a good, well-sealed foundation, and the rest will be easier. You can insert wire into this first pour to reinforce your concrete structure and get good adhesion to the subsequent pours.

4.3.2. 2nd concrete pour

The second day on site is to complete the concrete works and then allow the concrete to cure for a few days, the general concept once complete is as shown below.





You can re-use material from the temporary sandbag weir at this stage. Ideally you want rough concrete surfaces, using river rocks to make it as natural looking as possible.

Rough surfaces will:

- Reduce slip hazards when manually cleaning the screen
- Allow for easier passage of aquatic life

Where possible provide shallow pools where aquatic life can rest as they migrate up the stream in the residual flow.

4.3.3. Solid rock sites

At some sites it may be possible to cut into the bedrock with a suitable rock saw and jack hammer to make a recess for the Coanda screen to sit in. It is then secured with anchors and concrete.

4.3.4. Flow diversion

In some cases you may need to divert the flow using a pipe or flume to a place that is better protected from floods and place the intake (with Coanda screen) there. Be sure to consider the effects of the overflow water that makes its way back to the stream, and prevent this from causing erosion.

4.4. Residual flow

Best practice requires that there is always some residual flow in the stream to ensure that aquatic life can survive. This flow is present all the time, bypassing the turbine intake.

Small hydro turbines that divert water replace it back to the stream lower down the same catchment. The effect of diversion is relatively minor compared to say permanent abstraction for irrigation, which deprives the entire river of the removed flow. The question is what should this residual flow be? In dry conditions stream flows are often measured to determine MALF (Mean Average Low Flow). MALF is measure of the minimum flow that aquatic life has adapted to survive in. If you always leave MALF in the stream you will not be generating for typically 2-12 weeks in dry summers. This may not be an issue for homes that have hybrid hydro and solar PV systems. It may be acceptable to have a residual flow of between 0-100% of MALF as every stream is different.

Once your turbine is operating, consume all the flow at MALF and then measure the flow in the stream just before the turbine exhaust flow re-enters the streambed. If this flow is at least 50% of MALF then any effect you are having will be minor. If less than 50% of MALF, open up the residual flow until you get this 50% figure. Seek advice from your local authority as rules vary.

5. Cleaning & Maintenance

Coanda screens are designed to be mostly self-cleaning. The triangle shaped wedge wire ensures that small stones <1.5mm fall through the screen and large ones flow over the screen and exit off the bottom.

In dry conditions when all the incoming flow is consumed you will observe leaves and twigs accumulate on the lower section of the screen until the next rain, when increased flow will wash the screen clean again.

The screens are designed to require minimal maintenance. To determine the maintenance required for a particular installation the screen should be monitored relatively frequently during the first year. In some cases where there is slime or algal growth cleaning visits may be required on a more regular basis.

In some water conditions there will be a growth of green slime or algae on the screen material. This can be removed with a stiff brush such as a yard broom with stiff bristles. The underside of the screen material should be inspected after 6 months to determine whether cleaning of the underside is required.

The vast majority of vegetative debris will be washed off the screens during periods of higher river flows. Pine needles and leaf stems may get stuck between the wedge wires over periods of several months. These can be removed using a stiff bristle brush.

Damage to the screen is possible if large boulders or trees are carried down the river during flood conditions. If this is likely (e.g. forestry upstream) then the intake should be checked for damage after each flood event. Spare Coanda screen inserts can be purchased and they are easy to replace if ever required.

At sites where there is a high silt load of abrasive material (e.g. pumice) the flow capacity of the screen will gradually reduce as the sharp edges of the wedge wire are rounded off. This will reduce the capacity of the screen and eventually the screen may need to be replaced.

In general it will take around 10 to 15 years for the flow capacity to drop below the rated capacity for a clean screen optimally installed. However, in some extreme cases where the silt has a high abrasive content this period is significantly reduced.

6. Install examples

In this section examples of Coanda installations will be presented that show a range of install situations.

6.1. Austrian install

In this example the Coanda intake is positioned on a side weir so is not subject to flood water issues, hence there is no need to encase in concrete.

To watch a video of this screen click here.

When connecting a stiff pipe to a plastic casing, there may be a need to heat set the pipe so that the parts align without stress on the join. A stressed join may leak.