

**Guidance for Treating Lightly Contaminated
Surface Run-off from Pig and Poultry Units**

**Supplementary Guidance for IPPC
Applications**

Northern Ireland Environment Agency

Report prepared by:
Carole Christian
Environmental Consultant

SAC
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Note that this guidance is intended to allow you to make an assessment as to what you may need to do to treat lightly contaminated site run-off from pig and poultry units. It is not intended to be a substitute for detailed professional advice. You may wish to seek such advice should you intend to put into place anything other than a simple swale system.

A spreadsheet tool to assist you in making the necessary calculations is available with this guidance. It can be downloaded from www.ni-environment.gov.uk You may wish to perform the calculations using the spreadsheet and include the printed results in with your IPPC application.

Important Safety Information

- All water is a potential danger to children. Small children can drown in surprisingly shallow water.
- You should conduct a thorough safety check and risk assessment for any swale, pond, constructed wetland or soakaway that you plan. Take advice from safety experts if you are in any doubts as to the best way to make the installation safe for all.
- Remember that dangers can be posed in both the construction and use phases.
- Remember to keep any Test Pits covered or fenced. Secure all manholes.
- Keep all slopes, particularly those close to or under water, as gentle as possible.
- Small children may be readily deterred by toddler fencing. Slightly older children may find shallow, boggy, well-planted margins or prickly planting make it unattractive to get dangerously close to water. Older children may find high fences a challenge to be overcome, but again might be deterred by a dirty and uncomfortable approach.
- After consideration, you may decide that warning notices and life belts would be appropriate, particularly in the vicinity of deeper water.
- Remember too, that even lightly contaminated site run-off from pig and poultry units may contain biologically active materials. All personnel coming into contact with this run-off should pay normal attention to hygiene and hand-washing.

Why does run-off from pig and poultry units need to be treated?

Run-off from surfaces nearby any agricultural operation can contain some or all of the following in various quantities ranging from gross contamination to traces:

- Faecal matter, including nutrients, pathogens and heavy metals
- Feed
- Bedding
- Dander, feathers etc
- Disinfectants, veterinary medicines etc

Pig and poultry units are no exception to this. Indeed, because of the intensive production environment, the concentration of such contaminants can be higher in areas surrounding pig and poultry housing than around less intensive installations.

Damage to the environment from some or all of the contaminants listed above can occur through eutrophication, acidification, build-up of substances in soils, ecosystem damage and reduction of amenity. Because of the requirement under 'Standard Farming Installation Rules' to appropriately handle and treat all contaminated run-off, it is in the operator's best interest, as well as being a requirement of the rules, to effectively separate relatively dirty and relatively clean run-off. This can be achieved by keeping surfaces such as building aprons and roofs as clean as possible so that any rainfall coming into contact with these surfaces can be treated as "lightly contaminated".

Treatment of lightly contaminated run-off can reduce the contaminant load or potency by allowing pathogens to die off before they reach natural surface or ground waters, trapping sediments containing nutrients and heavy metals, and allowing for controlled plant uptake of some of the nutrients thereby keeping them out of the natural ecosystem.

Why use swales, ponds, wetlands and soakaways to treat run-off from pig and poultry units?

Treatment methods proposed in this guidance and required by standard farming installation rules mimic some of the properties of natural wetland systems. They are very appropriate for the treatment of lightly contaminated agricultural surface run-off because they are . . .

- . . . *reliable* - the technology is established and proven world-wide to be effective and long-term
- . . . *efficient* - they have very low operating and maintenance costs compared to traditionally engineered solutions
- . . . *flexible* - they can withstand significant daily and seasonal fluctuations in load and this makes them suitable for a wide variety of settings and weather patterns
- . . . *capable* - they can achieve very high standards of water quality making them very suitable for sensitive locations
- . . . *simple* - they are a practical, environmentally-friendly and sustainable alternative to conventional run-off treatment, particularly in rural areas
- . . . *sensitive* - swales, ponds, wetlands and soakaways can provide both a good solution to a lightly-contaminated water problem and a great visual and habitat feature

They provide a natural way to treat contaminated water originating from a wide variety of sources and with varying contamination problems including:

- Suspended Solids (SS)
- Ammonia (NH₄)
- Biochemical Oxygen Demand (BOD)
- Acidity
- Metal Precipitation

Since phosphorus contamination in agricultural settings tends to be bound to sediments, the potential of swales, ponds, and constructed wetlands to either entrap or settle out sediment can encourage phosphorus to be contained too. However, care must be taken when disturbing these sediments during maintenance so as not to re-release the P back into the natural environment in a damaging surge.

What treatment options do the rules permit?

The treatment options outlined in this guidance comprise swales, ponds, wetlands and soakaways. Either one, or a combination of one or more of these methods can be tailored to meet individual requirements with run-off types, loadings, site characteristics and discharge standards all being included in the design.

Swales are shallow grass-lined channels designed to collect water and move it gradually away downslope. They can encourage infiltration along their route and the grass can provide filtration of suspended sediments as well as taking up nutrients. Commonly, check dams are used along their length to increase their storage capacity and to slow water flow.

Ponds can be designed to be at the end of a swale or of another water collection system. They are intended to allow suspended solids to settle out of run-off and/or to store a storm water surge until it can pass through the extended system.

Constructed Wetlands are intentionally flooded areas with a combination of deep and shallow water. They can have a deeper channel running sinuously from inlet to outlet, or a gradually shallowing or stepped depth wetland, with the shallow water areas planted up with aquatic and/or emergent vegetation.

Soakaways can be used where soils are sufficiently permeable and the groundwater table is low enough. However, the run-off must have contaminant levels below critical thresholds as otherwise they may be fast-tracked into groundwater via a soakaway. Soakaways permit the seepage of run-off through surrounding soil **above** the water table. The soil provides the medium in which treatment by bacteria takes place, and cleaned water eventually reaches the water table.

Depending on the gradients on site, various level control devices and connectors would also be required. These would be designed for simple construction, minimum maintenance, long-term operability and landscape fit.

Swales

What is a Swale?

Swales are shallow grass-lined channels designed to collect water and move it gradually away downslope. They can encourage infiltration along their route and the grass can provide filtration of suspended sediments as well as taking up nutrients. Commonly, their storage capacity is increased and the rate of water flow along their length is decreased by the construction of check dams.

Unlike ditches, they are normally dry outwith wet weather and their sides and base are grassed. The grass needs to be kept to a height of approximately 100mm – you can do this by mowing, strimming or light grazing.

What are the benefits of using swales?

- Swales are
- effective at improving water quality
 - cheaper to construct than piped systems
 - able to be incorporated into the landscape
 - a low-maintenance option
 - visible in operation

What makes a good swale?

- The longer the swale the better. A longer swale gives more time for the entrapment or settlement of suspended solids. Swales of more than 70m length are optimal.
- Swales should have no sharp bends – they should curve gently.
- Swales should have shallow gradients of no more than 5°. Steeper ground than this can have a swale built on it but the swale should curve to and from across the slope with a shallow gradient. Take care that, as above, the curves are gentle.
- Swales should have gently sloped sides with a gradient no steeper than 1:3. This can make the whole swale rather wide though. If you need to, make the bottom of the slopes of the swale shallow and steepen them as you go upwards. Keep the slopes safe though.
- An established grass sward is beneficial and so standing water should be avoided.

Where should the swale be located?

This will depend on the layout of the site and, in particular in the case of a retrofit, on the available space. Normally though the swale would run either parallel with or at right angles to the run of the houses with hard-standing areas draining towards the swale.

Note that, to comply with Standard Farming Installation Rules 2.3.3.3 (pigs) and 2.3.3.4 (poultry), outflow points from hard-standing to swale should be able to be blocked off to contain heavily contaminated run-off such as may occur during wash downs. At these times, run-off should be collected and diverted to waste tanks for subsequent land spreading.

On large sites, subsidiary swales between houses may link with a main swale off to one side. Roof water may be led to swales via clean surface drains or small swales.

How do I design a swale?

The key to designing a swale is to know the size of the area being drained. This is the area of lightly contaminated hard-standing and roof that is going to be contributing run-off to the swale. To size the swale, this area is multiplied by 12mm in order that the first 12mm of rainfall in any one rainfall event can be held in the swale – any additional run-off will overflow downhill. This volume of run-off (area x 12mm) is known as the Treatment Volume, V_t . 12mm is chosen because that amount of rain will generally lift any light contamination from the surface and further rain after that is likely to run clean. The gradient of the slope is then used to calculate how many check dams are required and then their spacing and sizes are calculated.

Here is a worked example.

Step	Worked Example Data
1 Measure the roof and hard standing areas	5450 m ²
2 Work out the swale length available on site	120 m
3 Measure the gradient along the line of the swale (see Swale Note 1 for how to do this, or use a inclinometer)	2%
4 Calculate the Treatment Volume, V_t	$5450 \times 0.012 = 65.4 \text{ m}^3$
5 Calculate the number of check dams . . . a from Swale Table A, look up the distance between check dams for the gradient determined in Step 3 b divide the Swale Length from Step 2 by the distance between check dams from Step 5a to work out how many are needed	25 m $120 / 25 = 4.8 \cong 5$ (round your answer up)
6 Calculate the volume of the check dams. . a from Swale Table B, look up the volume held by each check dam. Initially assume a swale floor width of 1 metre. b multiply the volume per check dam (Step 6a) by the number of check dams (Step 5b)	10m^3 $10 \times 5 = 50\text{m}^3$
7 Ensure that the volume of all the check dams will contain the Treatment Volume, V_t	Volume held = 50m^3 but $V_t = 65.4\text{m}^3$ - volume insufficient
8 If the volume is insufficient, repeat Step 6 and Step 7 using a greater floor width	Floor width = 1.5m Single check dam = 13.1m^3 Volume held = $(5 \times 13.1) = 65.5\text{m}^3$ this is OK

Swale Table A – Distance between check dams

Swale gradient %	1	2	3	4	5
Distance between check dams m	50	25	16.5	12.5	10

Swale Table B – Volume per check dam

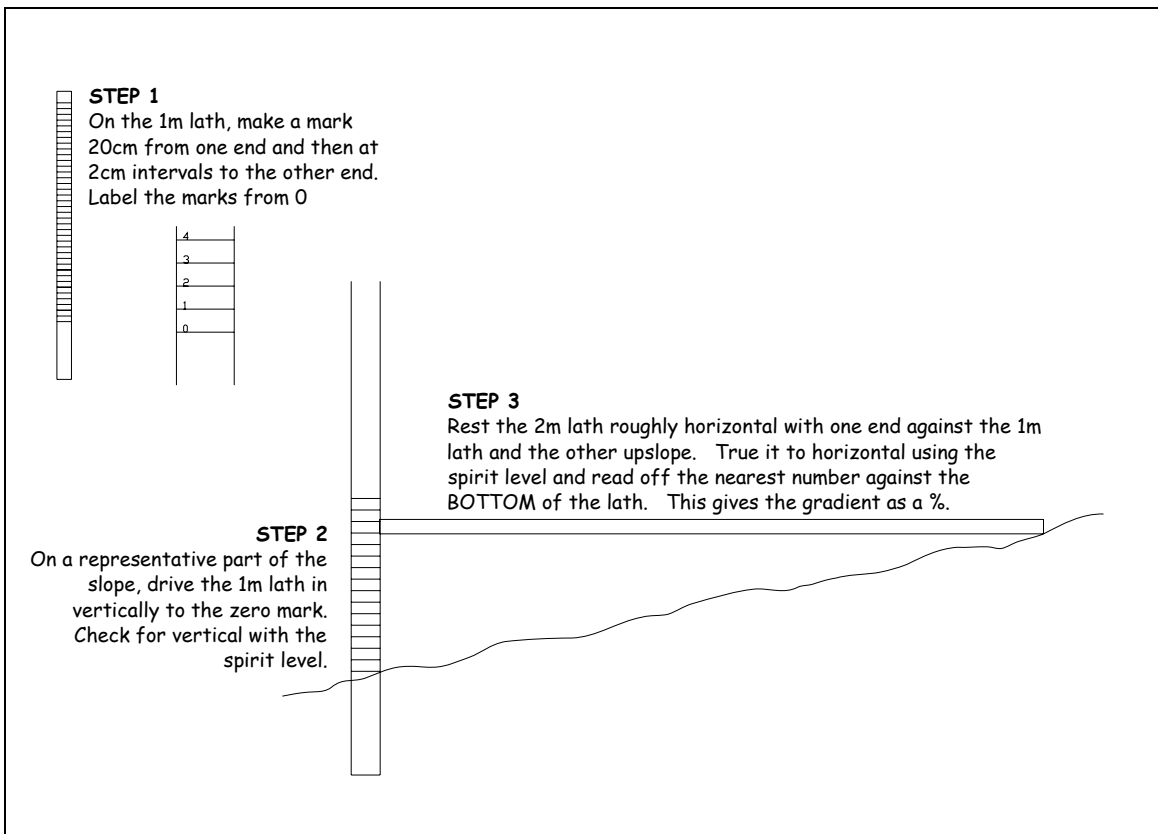
		Swale gradient %				
		1	2	3	4	5
Floor width m	1.0	20.0	10.0	6.7	5.0	4.0
	1.5	26.3	13.1	8.8	6.6	5.3
	2.0	32.5	16.3	10.8	8.1	6.5

Swale Note 1 - Measuring gradients without needing a survey

You will need:

Two sturdy wooden laths, one 2m long and one 1m long

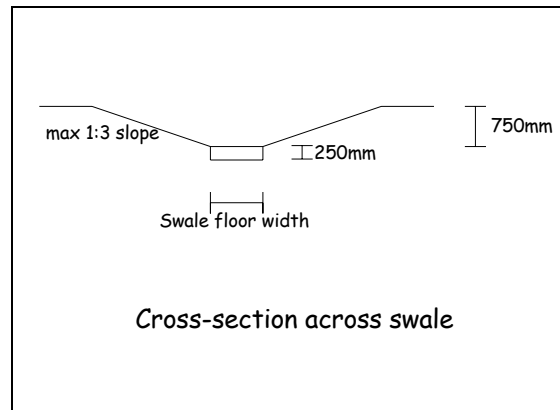
A spirit level



How do I build a swale?

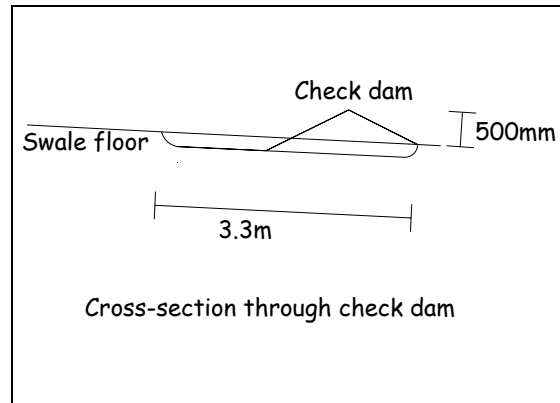
First excavate the line of the swale

- Excavate the swale to a depth of 750mm. Store the topsoil separately
- Make the width of the swale floor equal to the width calculated. Where possible make the side slopes no steeper than a 1:3 slope - use a shallower slope if space permits.
- Excavate the floor of the swale a further 150-250mm and fill the resulting trench with some of the retained topsoil



Now build the check dams

- Excavate a trench across the swale 200mm deep and 3.3m long
- At the lower end of each trench, build up the check dam from the 75-150mm grade broken stone to a height of 500mm above the floor of the swale. The sides of the check dam should have a 1:2 slope.



To finish the swale

- Spread the remaining topsoil over the sides of the swale and apply fertiliser and/or lime as appropriate to bring the nutrient content and pH to a standard to enable the grass to establish quickly. BS 3992:1994 "General Purpose Topsoil" specifies good topsoil parameters.
- Grass the swale with a mixture that requires little maintenance and provide a dense, well-knit sward. For instance, a mixture of 70% creeping red fescue, 20% smooth-stalked meadow grass and 10% creeping bent. Apply the grass mixture at about 24 grams per m² or 240kg per hectare.

Ponds

What is a pond?

Ponds are bodies of open, relatively deep water with shallower margins. Their shallower vegetated edges help with sediment capture, habitat creation and safety. The deep water encourages sediment settlement. They are designed to provide a buffer for storm events by allowing storage of water before it passes further down a treatment system. Their capacity to store water also gives time for some treatment of biological contaminants through “die-off”.

Note that a pond is not a substitute, in the context of the treatment of lightly contaminated site run-off from pig and poultry units, for a constructed wetland. As the Constructed Wetland section of this guidance explains, the special properties of the marsh zone of the wetland give opportunities for biological treatment of both nutrients and biologically active components of run-off that don't exist in a deep-water pond.

What are the benefits of using ponds?

Ponds are

- good at slowing down flow through a system
- good at containing a large volume of water for time-based treatment
- effective at trapping sediment and therefore trapping heavy metals, nutrients and other sediment-bound contaminants
- attractive habitats and landscape features
- visible in operation

What makes a good pond?

- A shallow-water planted-up margin gives three benefits. The plant stems give plenty of opportunity for trapping sediment. The shallow wet platform gives good opportunities for insects and amphibians. Children and inquisitive adults are deterred from getting too close to the deep part of the pond by a muddy, thickly vegetated fringe.
- The deep water, up to 1m, encourages sediment to fall out. It should be accessible for periodic de-sludging – either a digger or a slurry tanker could be used for this (remember not to create too much disturbance to the sediment when de-sludging though – certainly don't “mix” it like slurry).
- Some tall waterside planting can help give a variety of habitats and a more natural appearance, but the pond must not be unduly shaded. Try to have a transition zone of rough grass and shrubs between the pond and surrounding grassed areas. This will benefit wildlife as well as creating a slightly more natural appearance.
- A “calm” pond is best able to settle out sediment and is less likely to re-suspend sediment once it has settled. Having the inflow below the water surface helps to reduce splash and turbulence.
- Heavy livestock should be kept out of the pond. Light grazing of surrounding grass areas by, for instance, sheep can be beneficial.

Where should the Pond be located?

This will depend on the layout of the site and on the space available. In a typical on-farm setting, they should be immediately “below” any swales carrying water from the steading and “above” any Constructed Wetlands or soakaways. Putting them early on in the system gets the best out of their ability to remove sediment - this takes out a major source of contaminants leaving the rest of the system able to do some “polishing” of the water. It also allows the pond to protect the lower parts of the system from high flows after rain storms.

Ponds are designed to hold water and lining them is an expensive and problem-prone option. Ideally therefore they should be on an area of impermeable sub-soil, preferably clay. A clay content of at least 20% should provide the necessary watertight base.

Because of the deep water, it is necessary to provide a safety margin around the pond to minimise the chances of anyone falling in accidentally. Back-slopes above the pond should be as gently sloped as possible, ideally no more than 1:4. Siting a pond on a piece of ground with a significant slope will therefore take up a large amount of space if there is to be a safe surround as well as a deep pond section. Keep the pond to gently sloping areas of ground where possible.

Don't be tempted to incorporate an existing natural pond. It is not acceptable to use natural water features for treatment of even lightly contaminated water.

Be very cautious about starting to build a pond in a very boggy piece of ground and certainly avoid areas with peaty soils. It would be very easy to create nothing other than an unstable mess and could create more problems than it solves.

How do I design a Pond?

Firstly, you need to determine the area of roof and hard-standing that will be contributing run-off.

Step		Worked Example Data
1	Measure the roof and hard standing areas	8400 m ²
2	For each wetland, calculate the volume of rainfall resulting from a 12mm rainfall event. This is the Treatment Volume, V _t	8400 * 12 / 1000 = 100.8m ³
3	CIRIA publication C521 “Sustainable Urban Drainage Systems - design manual for Scotland and Northern Ireland” recommends that the volume of water in a pond is four times the Treatment Volume, V _t	100.8 * 4 = 403.2m ³
4	Assuming that the pond is to be roughly square (which it doesn't need to be) the sides will each be	√403.2 = 21m
5	You should add a shallow planted margin of at least 2m width all round for safety and additional sediment trapping. So overall size would be	24m x 24m

How do I build a Pond?

- Mark out the overall length and width of the proposed Pond using the calculated dimensions. It doesn't need to be square – you may find it much easier to create a long pond in the space you have – but the inlet and the outlet should be as far apart as possible within the pond. It doesn't need to be squared off either – a much more natural appearance could be created by curving the corners and following the landscape.
- Remember safety at all times. Ensure that slopes are as gentle as possible and certainly no steeper than 1:3 above deep water or below water. Ensure that the site is always left safe during construction.
- For this pond to have an average depth of 1m it must go to 2m at its deepest. This is a significant hazard and it **MUST NOT** be possible for the pond to be accessed by children. Fencing off the pond should be seriously considered.
- There should be at least 500mm of freeboard above the normal water level.
- The water inlet pipe should be from 200-300mm below the finished water level to avoid splashing. This helps to avoid sediment being re-suspended during high flows.
- Install a larger diameter pipe at the outlet than at the inlet. This will help to avoid flooding should the outlet pipe become partially blocked. Surrounding the outlet pipe with a mesh screen, and checking it regularly, will also help reduce flood risk. If the outlet pipe is fitted vertically on a 90° bend, the top height and hence the pond's water level can be altered by rotating the joint slightly.
- The regulatory body may require you to have a water sampling point at the inlet or the outlet end of the pond. If they do, ensure that safe access and a secure footing is available for personnel taking water samples.
- If possible, create an overflow channel by excavating a shallow depression in the banking. Face it with stone to avoid erosion and ensure that it will overflow to a "safe" area.
- When planting up the margins, do not introduce any exotic plant species. Wherever possible, use plants that occur naturally in the locality. If there is a waterbody close by, natural colonisation will occur. Also, help invertebrates to colonise by scooping a pail of sediment and water out of a nearby watercourse and adding that to your finished pond.

Constructed Wetlands

What is a Constructed Wetland?

Constructed Wetlands are designed to mimic natural pond and wetland systems. They can take a wide variety of forms but they will all have at least an area of relatively deep water at their inlet end which does three things:

- The deep area allows sediments to settle out
- The deep area can help to contain water coming from a sudden storm event and so provide some storage capacity
- Delaying the movement of the water through the system by giving it a deep area to pass through first allows time-based water treatments to start and encourages, for instance, pathogens to die off

Constructed Wetlands will also have a “marsh zone” with varying depths. The deeper marsh comes first and the water depth will gradually decrease until, at the outlet end, the depth is as little as 100mm or less. This marsh zone provides for a variety of vegetation types, and habitats too. The different vegetation gives different biological treatments for nitrate removal and nutrient uptake as well as physical treatments such as sediment entrapment.

What are the benefits of using Constructed Wetlands?

- Constructed Wetlands are
- good at slowing down flow through a system and containing a large volume of water for time-based treatment
 - good at encouraging sediment settlement and entrapment
 - excellent at providing habitats and landscape benefits
 - when properly designed, provide a low-maintenance and effective treatment option

What makes a good Constructed Wetland?

- A good Constructed Wetland has a deep pond at the inlet end.
- A planted shallow bund immediately after the deep pond provides a physical buffer to sudden inrushes of water following a storm. It encourages the water to spread out and the planting provides a further sediment trap.
- The marsh zone should have a gradually decreasing water depth from bund to outlet and should be planted to vegetation typical of the area (it may be allowed to partially colonise naturally).
- A planted shallow bund or sub-surface barrier separating the deeper first part of the pond from the shallower second part is an important feature. The planted bund filters sediment, slows down flow and spreads it out across the surface. See the section on “**How do I build a Constructed Wetland?**” for details of bunds.
- Although seasonal variations in pond depth can be tolerated, and indeed can give a more natural appearance and better biodiversity, the pond must have enough of a water supply in the summer that it doesn’t dry out.
- Some tall waterside planting can help give a variety of habitats and a more natural appearance, but the pond must not be unduly shaded. Try to have a transition zone of rough grass and shrubs between the pond and surrounding grassed areas. This will benefit wildlife as well as creating a slightly more natural appearance.

- A “calm” pond is best able to settle out sediment and is less likely to re-suspend sediment once it has settled. Having the inflow below the water surface helps to reduce splash and turbulence.
- A long pond rather than a round pond means fewer deadspots in which water could become stagnant. This will reduce any tendency for the water to become stale and to start to smell.
- Heavy livestock should be kept out of the pond. Light grazing of surrounding grass areas by, for instance, sheep can be beneficial.

Where should the Constructed Wetland be located?

A constructed wetland should not be formed on the site of an existing wetland of high biodiversity or ecological importance. You should check this before you begin to plan. In a system to treat lightly contaminated site run-off from pig and poultry units a Constructed Wetland should come “after” one or more swales. If the anticipated sediment load is particularly high it should be immediately preceded by a stand-alone pond but the pond cannot substitute for the constructed wetland.

Much of the advice for the location of ponds also applies to Constructed Wetlands. As with ponds, Constructed Wetlands are designed to hold water and lining them is an expensive and problem-prone option. Ideally therefore they should be on an area of impermeable sub-soil, preferably clay. A clay content of at least 20% should provide the necessary watertight base.

Because of the deep water, it is necessary to provide a safety margin around the deep part of the Constructed Wetland to minimise the chances of anyone falling in accidentally. Back-slopes above the pond should be as gently sloped as possible, ideally no more than 1:4. Siting a pond on a piece of ground with a significant slope will therefore take up a large amount of space if there is to be a safe surround as well as a deep pond section. Keep the pond to gently sloping areas of ground where possible.

Don't be tempted to incorporate an existing natural wetland. It is not acceptable to use natural water features for treatment of even lightly contaminated water.

Be very cautious about starting to build a Constructed Wetland in a very boggy piece of ground and certainly avoid areas with peaty soils.

How do I design a Constructed Wetland?

As with all other designs presented in this guidance, the first step is to determine the area of roof and hard-standing that will be contributing run-off. You then need to decide whether you plan to build several small Constructed Wetlands or one larger one. The sizes of the pond, bund, and the varying depth marsh zones can then be calculated, including an estimation of the number of reed seedlings needed to plant up the bund.

Step		Worked Example Data
1	Measure the roof and hard standing areas	8400 m ²
2	How many similarly sized wetlands do you wish?	3
3	Divide the contributing area by the number of wetlands	8400 / 3 = 2800 m ²
4	For each wetland, calculate the volume of rainfall resulting from a 12mm rainfall event. This is the Treatment Volume, V _t	2800 * 12 / 1000 = 33.6m ³
5	CIRIA publication C521 "Sustainable Urban Drainage Systems - design manual for Scotland and Northern Ireland" recommends that the volume of water in a treatment wetland is three times the Treatment Volume, V _t	33.6 * 3 = 100.8m ³
6	The average depth of the wetland including the deep pond will be 0.6m, therefore calculate the wetland area.	100.8 / 0.6 = 168m ²
7	Add 30% to the wetland area to accommodate a marginal shelf.	168 * 1.3 = 218m ²
8	The length:width ratio of the wetland is important. A wetland that is long and narrow rather than short and wide is best. A length:width ration of at least 2:1 is recommended. Enter your desired length:width ratio.	2:1
9	Using the length:width ratio, calculate the length and width of the wetland.	Length = 21m Width = 11 m
10	The pond will comprise the first third of the length of the wetland. Calculate the position of the bund. The bund's top will be 100 to 150mm below the water surface. The bund's top surface will be 1m wide.	21 / 3 = 7m from the inlet

11	The three marsh zones will each take up one third of the remainder of the length of the Constructed Wetland. So, each zone will be :-	$(21 - 7) / 3 = 4.7$ m long
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How do I build a Constructed Wetland?

- Mark out the overall length and width of the proposed Constructed Wetland(s) using the calculated dimensions. The finished wetland need not be perfectly squared off – a much more natural appearance could be created by curving the corners and following the landscape. However, the overall shape should have the length:width ratio used in the calculations. Avoid :
 - narrow waists
 - “dead” spots
 - tight bends
- Remember safety at all times. Ensure that slopes are as gentle as possible and certainly no steeper than 1:3 above deep water or below water. Ensure that the site is always left safe during construction.
- There should be at least 500mm of freeboard above the normal water level.
- The water inlet pipe should be from 200-300mm below the finished water level to avoid splashing. This helps to avoid sediment being re-suspended during high flows.
- Install a larger diameter pipe at the outlet than at the inlet. This will help to avoid flooding should the outlet pipe become partially blocked. Surrounding the outlet pipe with a mesh screen, and checking it regularly, will also help reduce flood risk. If the outlet pipe is fitted vertically on a 90° bend, the top height and hence the wetland’s water level can be altered by rotating the joint slightly.
- The three varying-depth marsh could be three separate zones with a stepped join between them, or they could be a continuous gradually-shallowing slope from the bottom of the bund up to the outlet end.
- The regulatory body may require you to have a water sampling point at the inlet or the outlet end of the Constructed Wetland. If they do, ensure that safe access and a secure footing is available for personnel taking water samples.
- Depending on the size of the Constructed Wetland, it may be help to even out flow and avoid dead spots to have more than one outlet across the “outlet” end of the shallow marsh. Consider more than one outlet if the width of the Constructed Wetland is greater than 5m. An exit trench, with a perforated pipe across the “shallow” end of the marsh zone, may be preferable.
- If possible, create an overflow channel by excavating a shallow depression in the banking. Face it with stone to avoid erosion and ensure that it will overflow to a “safe” area.
- When planting up, do not introduce any exotic plant species. Wherever possible, use plants that occur naturally in the locality. If there is a waterbody close by,

natural colonisation will occur. Also, help invertebrates to colonise by scooping a pail of sediment and water out of a nearby watercourse and adding that to your finished Constructed Wetland.

When might I want a pond and a constructed wetland?

In situations where run-off is relatively heavily contaminated, the benefits of having a stand-alone pond as well as a constructed wetland are considerable. Although, in these cases, the normal route for water could be swale-pond-wetland-discharge, with a parallel pond the flow could be switched in the event of a contaminating spillage. The initial contaminated run-off could be caught in the pond and the pond then could be isolated by switching the flow to the route swale-wetland-discharge. This would give the opportunity to pump out the pond and remove the contaminant from the system. Normal routing could then be restored. Or, when sediment was being removed from the constructed wetland's deep pond, the stand-alone pond could be used to collect run-off until the de-sludging was complete.

Soakaways

What is a Soakaway?

Soakaways are a way of encouraging surface run-off to soak into the ground. In natural ground, there will be areas that drain and dry quicker than others after heavy rain, and a constructed Soakaway is a way of mimicking this rapid movement of water.

Because of the relatively rapid movement of water from the surface to the ground, Soakaways offer a “fast track” both for the water itself but also for any contaminants that it contains. It is therefore crucial that Soakaways are not used where there is a possibility of contaminants over threshold levels being present in the water.

What are the benefits of using Soakaways?

Soakaways are

- good at dispersing excess surface water to ground
- hidden, with few limitations on the use of the ground above

What makes a good Soakaway?

- Key design properties for a soakaway are the volume of water to be drained away, the capability of the soil and sub-soil to conduct the water and the depth of the water table below ground.
- The best soakaways will be designed to be of sufficient size to handle likely maximum flows.
- The soil percolation rate can be measured by the use of test pits and, provided that it is above a threshold rate, the soakaway can be designed accordingly. If the percolation rate is too low then a soakaway will not be appropriate.
- The depth of the water table is crucial. There must be at least 1m between the floor of the soakaway and the water table. If the water table is higher than this then the water will not drain away quickly enough. If the water table is high because of a thin clay layer, it may still be possible to build a successful soakaway by digging below that layer.
- The soakaway operates below ground and there is no reason why the ground surface should not be in normal use - grazing and even arable use is quite possible. Subsoiling over the soakaway should definitely be avoided though.
- The soakaway should operate unseen and without any requirement for maintenance. An accurate plan of its location should be made at the time it is installed as it may be very hard to find after a few years.
- A soakaway site should be level or very gently sloped. On sloping ground, the soakaway trench can contour the slope – it is crucial that this should be constructed accurately though, as otherwise the water could all run to a low point and then overflow.
- When more than one soakaway is to be used, don't site them closer together than 2m.

Where should the Soakaway be located?

This will depend on the layout of the site and on the space available. However, the soakaway needs always to be at the “bottom” of the proposed system, lower than the area to be drained. The best site will depend on very local conditions of soil permeability and water table depth.

An already wet spot is obviously unsuitable so avoid any ground that grows rushes or buttercups. Don't put a soakaway at the top of a steep bank or in areas that could be

crossed by heavy vehicles. And don't put a soakaway closer than 5m from a building, 10m from a natural surface watercourse, or 50m from any springs, wells or boreholes which provide drinking or dairy wash water. No part of a soakaway should be within 10m of any field drains – permeable drains that are closer than 10m could be replaced by solid-walled drains over the length of the 10m zone.

How do I design a Soakaway?

The first step in designing a soakaway is to find out the soil infiltration rate, that is the rate at which the soil will allow water to pass through downwards and outwards. This is then used, along with the area to be drained to work out how large the soakaway needs to be to quickly drain away the volume of run-off that that area will generate. The soakaway size calculations use several different "storm" durations.

See Soakaway Note 1 for how to conduct a soil infiltration rate test. To determine the number of test pits you need to dig, first of all dig one and carry out the test on it. Use this to make an estimate of the total soakaway length and then dig a test pit roughly every 50m along the line that you propose the soakaway will take.

Remember that you may have more than one soakaway if necessary. The soakaway may snake back and forth across level ground (provided that you keep the floor level across the whole soakaway). It could also be stepped down a slope by digging a series of shorter level soakaways across the slope and linking them by pipe with a level control device on all but the lowest. Don't plan to build them immediately alongside each other though – leave at least 2m of undisturbed soil between soakaways.

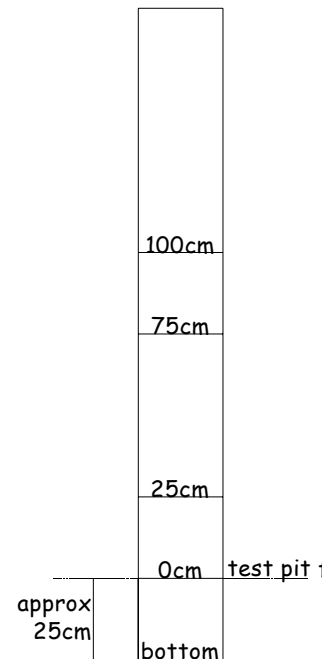
Safety notes

- The test pits will be 1.5m deep and, if the site is wet or it rains, they may be partly filled with water. Precautions should be taken either by fencing them off or by securely covering them, to ensure that children or others cannot fall into them accidentally.
- Also, whilst the test pits are not so deep that their sides need, under normal circumstances, to be shored, unstable soil conditions may make shoring necessary. In this event, you should seek expert advice and not enter the test pits until they are in a safe condition.
- It should not be necessary to enter the pits to conduct the test. Once the test is completed, the test pits should be filled in as soon as possible.

Soakaway Note 1 – conducting a soil infiltration test

Note that you will require a lot of water for this test – 6m³ per test pit. For each test the water needs to be poured in as quickly as you can manage. Flood the water in as quickly as you can whilst ensuring that you don't undercut the pit sides.

- Along the proposed line of the soakaway, dig a series of test pits with due regard to the safety notes above.
- Each pit should be 2m long, 1m wide and 1.5m deep. Try to get the pit as close to this as possible.
- Cover the pits for 48 hours. If after that time, they have standing water in them, then the site is not suitable for a soakaway and the test can stop. (Note that you may wish to dig just one pit to begin with and inspect this after 48 hours. If it is dry, proceed to dig the rest and leave them all for a further 48 hours).
- Take a 2m long stick and mark it up as shown alongside. Push the bottom end of the stick into the floor of the trench and up to the 0mm mark. Support the stick to keep it as upright as possible.
- As quickly as possible, fill the test pit to the 1000mm mark on the stick. This will require 2m³ of water and will result in the test pit having 1m depth of water in it.
- *** Allow the water level to fall to the 750mm mark. Note the date and the time.
- Allow the water to fall to the 250mm mark. Note the date and the time.
- Subtract the two times to give the number of minutes for the water level to drop from the 750mm mark to the 250mm mark.
- Re-fill the pit to the 750mm mark and repeat from ***. Do the whole test three times.
- Take the average of the three measurements and record this as the result for Test Pit 1. Repeat the whole procedure for the remaining test pits. You may find as you progress that you can run two or more tests at the same time).
- You will now have one test result for every Test Pit. Calculate the overall average result. You will use this to work out the Soil Percolation Rate for you



You may find it convenient to record all your test pit results in the Soil Percolation spreadsheet and to then use the calculated overall average time to work out the Soakaway Design.

How do I build a Soakaway?

- The soakaway trench should be built with the dimensions calculated
- Reserve the topsoil
- Try not to “polish” the walls of the trench as is being dug
- The trench should be as level as possible from one end to the other
- Where possible, plan the soakaway trench so that it has more than one inlet
- At each inlet point you should construct a wet well
- Line the sides (but **not** the base) with a geotextile fabric
- Fill the trench to a depth of 900mm with a granular material
- Lay the distributor pipe
- Finish the soakaway

Wet Wells

At each point at which water enters the soakaway, build a wet well. This can be constructed from concrete rings or from twin-walled pipe. Finish the wet well with a secure access cover. The invert (or bottom edge) of the pipe entering the wet-well should be at least 1m above the base of the wet well.

Geotextile Fabric

After the inlet pipes have been connected to the wet wells, line the sides (but **not** the base) of the trench with a geotextile such as Terram 500.

Granular Fill

Fill the soakaway trench to a depth of 900mm with granular material. This can be any stable, inert material that has a pore space of at least 30%. Washed gravel or crushed stone are typical fill materials

Distributor Pipe

Lay 100mm internal diameter perforated field drainage pipe on top of the 900mm of the granular fill and along the centre line of the trench. Connect the ends of the pipes into the wet well(s). Attach a T-piece to the ends of the pipe within the wet well. Arrange the T-piece so that the free ends are vertical.

Finishing the soakaway

Continue to fill the soakaway trench with granular fill material until the depth of fill is 1000mm. Cover the granular fill with geotextile. Cover the geotextile with the reserved topsoil. Record the exact position of the soakaway trench as future subsoiling or drainage work within 10m of the trench must be avoided. Grass down exposed surfaces as soon as possible.

Summary

How do I bring this all together into a plan?

The first consideration should be, if at all possible, to use the natural fall of the land to transport the run-off through the system. The use of pumps has considerable drawbacks including purchase and installation costs, the potential for flooding should they or the power fail, and the costs of power and maintenance. Additionally they are not “sustainable” in that they require a power input. So, use gravity constructively.

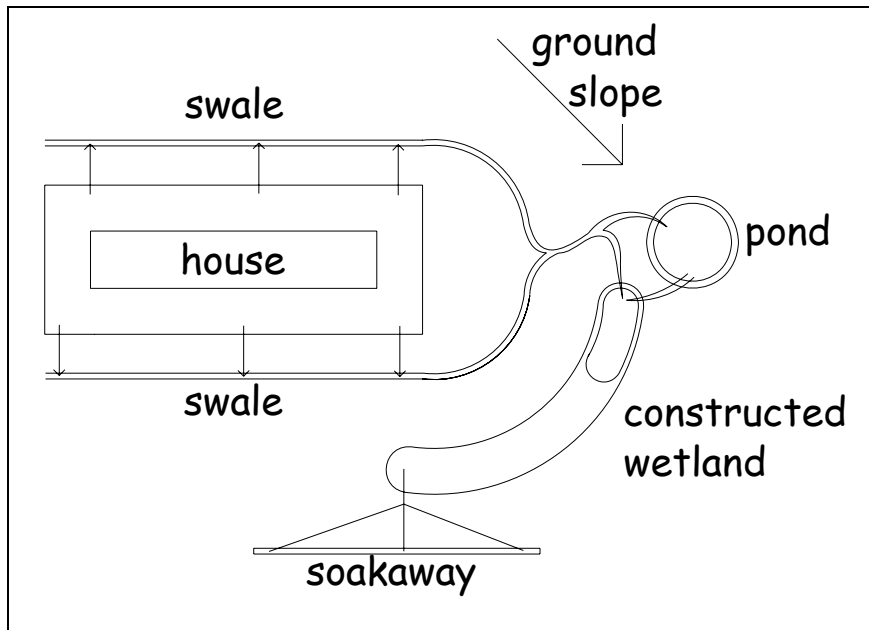


Illustration of idealised treatment system layout

The illustration above shows a layout of *idealised* treatment components for a hypothetical unit. In practice, however, all these components are unlikely to be used in any one system. Space is likely to be a limiting factor, particularly in many retrofit situations.

The Treatment Chain

You should think about the process of treating lightly contaminated site run-off from a pig or poultry unit in terms of a chain. The chain comprises collection, then treatment and finally discharge. Here is a table to help you identify which part of the treatment chain the different components belong to.

	Collection	Treatment	Discharge
Swale	✓	✓	
Pond		✓	
Constructed Wetland		✓	
Soakaway		✓	✓

Choosing Components

The IPPC Standard Farming Installation Rules in Northern Ireland require you to use at least **one** component to treat lightly contaminated run-off from pig and poultry units. Which one (or ones) are most relevant to your situation will depend on a variety of factors.

- Swales are ideal for collecting and transporting run-off but you may not have space for them.
- A Constructed Wetland can offer excellent treatment potential but will take up dedicated space.
- A Pond can help remove excessive sediment but doesn't offer the full treatment potential of a Constructed Wetland.
- A Soakaway is "hidden" but must not be used where there is a high level of contaminants.

You may need to compromise when deciding which components to use. For instance, you may have insufficient available space for a swale of the recommended size. In this case, you may decide, in addition to the partial swale, to design a small wetland to take up the remaining sediment in the run-off leaving the swale.

Or, you may not be able to use a soakaway on its own because of the potential for a higher than acceptable level of contaminants such as disinfection chemicals. In this case, you will need to allow for a long residence time by designing a wetland with a high "Multiplier for V_t " (V_t =Treatment Volume) to allow time for the contaminant to be neutralised before entering the soakaway.

Whatever compromises you make be sure to explain your decisions in your IPPC Application.

See overleaf for a decision tree to help you establish what your site may require.

Sustainability

If properly designed, this whole system should be self-regulating. Following the design principles outlined ensures that sufficient "volume" is built into the system that it doesn't flood out with the first heavy rain. There is enough of a time lag between run-off entering the system at the swale and it leaving the system for both the volume of rainfall to be buffered and for time-based treatment to occur. These features, combined with the opportunities for both physical and biological treatment, should result in effective, reliable and sustainable treatment of lightly contaminated site run-off from pig and poultry units.

System Component Decision Tree

