Guidelines for construction of swales for water quality improvement and flow attenuation of lightly contaminated runoff from poultry farms

What is a swale?

Swales are linear depressions formed in the ground to receive runoff and slowly move water to a discharge point. Unlike ditches, they are normally dry outwith wet weather and are grassed. Side and longitudinal slopes are gentle. The slow movement of water along the swale, aided by grass and check dams, encourages deposition of solids washed off the hard standing, and helps to remove nutrients such as phosphorus. Standard Farming Installation Rule 2.3.3.12 allows lightly contaminated drainage, e.g. from yard areas or roofs to be treated by means of swales or constructed wetlands.

What are the benefits of using swales?

- Improves water quality
- Cheaper to construct than piped systems
- Can be incorporated into the landscape
- Low maintenance
- Visible operation

What makes a good swale?

- The longer the swale the better. A long swale allows plenty of time for settlement of solids contained in the runoff. Swales of more than 70m in length give good, consistent performance.
- No sharp corners. Swales should have gentle curves.
- Shallow gradients. A swale which curves too and fro with a shallow gradient is better than a swale which is built directly down slope.
- Shallow swales with no permanent water have better chance of establishing a grass sward.

Where should the swale be located?

This will depend on the layout of the site and the amount of space available, but the swale would usually run either parallel with or at 90° to the houses, with the hard-standing draining towards the swale. To comply with Standard Farming Rule 2.3.3.2 outflow points into the swale should be capable of being stopped with a drain blocker so heavily contaminated runoff, such as may occur when cleaning out, can be diverted to waste effluent tanks. Larger farms may need more than one swale; a second swale could possibly be located between sheds. Roof water can be directed to the swale via surface drains or via smaller swales.

What is a check dam?

Check dams are small dams constructed across a swale. The check dam is made from graded broken stone. Runoff will pond behind the dam allowing sediment to settle out. As the check dam is made of stone, it will allow the ponded water to discharge slowly towards the outlet. This improves the efficiency of the swale.

What is the easiest method for designing a swale?

To improve water quality, the "first flush" of dirty water, washed off the hard standing, is trapped behind check dams built across the swale. This first flush is known as the treatment volume. To calculate the number of check dams needed to retain the treatment volume, follow the eight steps listed below.

Action	Example
Step 1. Measure the roof area and area of hard standing, A (m^2)	5,450m^2
Step 2. Establish the length available for the swale based on site layout, L (m)	120m
Step 3. Measure the land gradient for the swale (%)	2%
Step 4. Calculate the treatment volume V_t (m^3) = A × 0.012 see note 1	5,450 × 0.012 = 65.4m^3
Step 5. Calculate the number of check dams i) From table A, look up the distance between check dams for the gradient in Step 3. Initially assume the narrowest swale floor width of 1 metre. ii) Divide swale length L in Step 2. by the distance between check dams to calculate the number of check dams.	swale floor with = 1m gradient = 2% distance = 25m 120 ÷ 25 = 5 check dams
Step 6. Will the number of check dams store the treatment volume? i) From table B. look up the volume held by each check dam ii) Multiply the volume per check dam by the number of check dams.	Swale floor width = 1m Gradient = 2% Volume per check dam = 10m^3 10 × 5 = 50.0m^3
Step 7. If the volume stored by the check dams is less than the treatment volume increase the swale floor width	Swale floor width = 1.5m Gradient = 2% Volume per check dam = 13.1m^3 Volume of storage = 65.5m^3
Step 8. When the volume of storage behind the check dams is greater than or equal to the treatment volume proceed with swale construction.	Treatment volume V_t = 65.4m^3 Check dam storage volume = 65.5m^3 OK

Note 1: A value of 0.012 - 0.015 represents the quantity of the 'first flush' of runoff that will contain lightly contaminated washings. The values are obtained from "Sustainable Urban Drainage Systems: Design Manual for Scotland and Northern Ireland".

Table A Distance between check dams

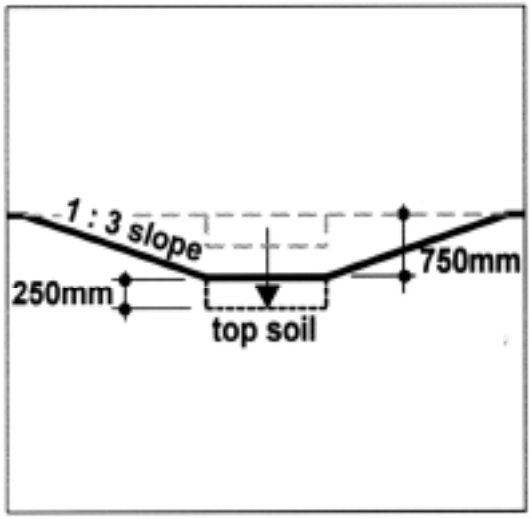
Swale gradient %	1	2	3	4	5
Distance between check dams (m)	50	25	16.5	12.5	10

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

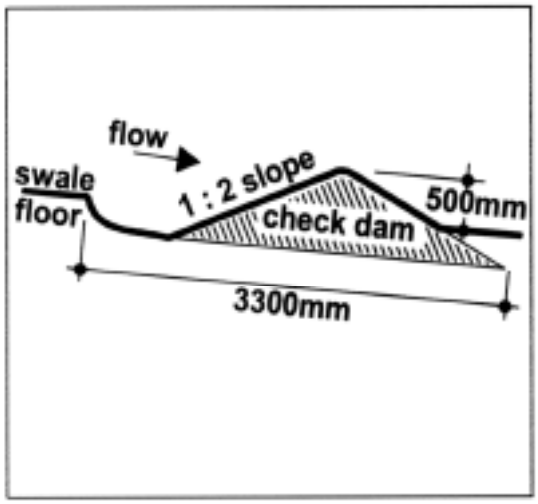
How is the swale constructed?

- Excavate the swale to a depth of 750mm.
- Store the top soil separately.
- Make the width of the swale floor equal to the width calculated in the 8 steps shown above.
- Make the side slopes 1 vertical to 3 horizontal or more gentle if there is enough room.
- Excavate the floor of the swale for a further 150 - 250mm depth and replace the excavated material with the top soil.



How are the check dams constructed?

- Excavate a trench across the width of the swale. Make the trench 200mm deep and 3.3m long.
- Build up the check dam from 75mm – 150mm grade broken stone to a height of 500mm above the **floor** of the swale. Build the check dam at the down slope end of the trench, leave the upslope end of the trench empty.
- The side slopes of the check dam should be 1 vertical to 2 horizontal



How is the swale completed?

- Grass the sides and the floor of the swale with a mixture that requires little maintenance and provides a dense well-knit turf. For example a mixture of 70% creeping red fescue, 20% smooth-stalked meadow grass and 10% creeping bent.
- Apply the grass mix at about 24 grams per m^2.
- Fertiliser and/or lime should be applied to bring the topsoil nutrient content and pH to within the recommendations of BS 3992:1994, "General purpose topsoil".