

# Farm run-off treatment systems—toolkit

This fact sheet is one of a series which provides advice to extension officers and land managers on planning and designing farm run-off treatment trains, specific to coastal agriculture in the wet/dry tropics region between central and Far North Queensland.

## Why is farm run-off treatment important?

Management of farm run-off can improve water quality by reducing the amount of nutrients, pesticides and sediments leaving the land and entering local creeks, rivers, wetlands and eventually the Great Barrier Reef. It can improve farm productivity by reducing the loss of good quality soils containing important organic matter, nutrients and microorganisms.

## How do you manage run-off on rural lands?

The management of farm run-off requires consideration of the farms' location in the landscape, farm layout and best management practices combined with farm run-off treatment (Figure 1).

Once other best management practices have been implemented to reduce the amount of run-off, there are a number of run-off treatment elements which can be used to improve run-off water quality. These include the use of buffer strips, vegetated swales and drains, sediment basins and constructed wetlands. These run-off treatment elements provide a toolkit from which individual systems can be selected to create a treatment train to suit the characteristics of each property and treat pollutants generated in a particular area.

## Run-off treatment toolkit

- Buffer strips
- Vegetated swales and drains
- Sediment basins
- Constructed wetlands
- Run-off capture and reuse

## What are farm run-off treatment trains?

Different run-off treatment elements provide different levels of treatment. In most cases, a combination of elements acting as a treatment train provides the best overall run-off treatment.

Treatment trains should typically consist of a combination of run-off treatment elements that can capture and remove both coarse pollutants (e.g. sediments) and fine and soluble pollutants (e.g. nutrients and chemicals). The treatment elements should be positioned in the train in that general order.

An understanding of the landscape setting for the farm, the adoption of best practice farm design and in-paddock management practices is essential to reduce the overall pollutant loss from the site and protect the treatment train from pollutant overloading and scour.

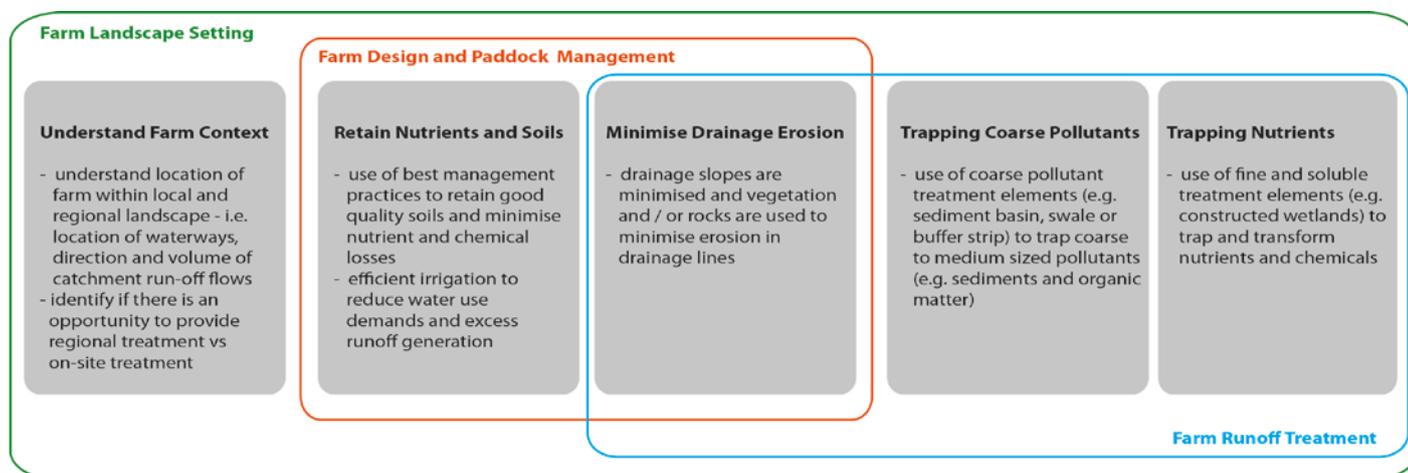


Figure 1 - Holistic farm run-off management framework

# Run-off treatment toolkit

## Coarse pollutant treatment elements

These elements usually target sediments with partial removal of particulate nutrients.

### Sediment basins

Sediment basins are run-off detention systems that target the removal (settling) of coarse sediment by reducing flow velocities (speeds) and by providing temporary detention. They can be used as a primary treatment element in a treatment train to protect downstream treatment elements from being smothered by sediments and they can also manage high flows through the provision of bypass devices.

### Buffer strips

Buffer strips are areas of vegetation through which run-off passes on its way to a discharge point. They may also be known as grassed filter strips. They reduce sediment loads by slowing run-off velocities, causing coarse sediments to deposit into the buffer strip. To optimise treatment performance, they need to be densely planted with multi-stemmed groundcovers and be located in areas where shallow (non-channelled) surface flows occur.

### Vegetated swales and drains

Vegetated swales and drains deal with both the quality and quantity of run-off flows by reducing flow velocities compared to piped, concreted or bare earth conveyance systems. They remove coarse and medium size sediments and are commonly combined with buffer strips and constructed wetland systems to provide further treatment. Multi-stemmed groundcover vegetation is crucial for water quality treatment in these systems. The main difference between swales and drains is how they hold water. Swales are located in areas which can fully drain and are therefore typically dry and can also be crossed or used as access tracks that are not used regularly. Drains are located on flat or backwatered locations which results in them holding water.



Newly constructed sediment basin. Photo: QDAFF



Buffer Strip. Photo: Peter Breen



Vegetated Swale. Photo: QDAFF



Drain. Photo: QDAFF

## Fine and soluble pollutant treatment elements

These elements aim to remove nutrients, bacteria, fine sediments and heavy metals.

### Constructed wetlands

There are many different types of constructed wetlands. For these factsheets constructed wetlands are densely vegetated water bodies that facilitate fine filtration, enhanced sedimentation and biological uptake to remove pollutants from run-off. The functional elements of constructed wetlands consist of a sediment basin, a macrophyte (reeds and sedges), zone and high flow bypass channel. Constructed wetlands can be very effective at treating low flow run-off events and irrigation tail-water.



Vegetated Swale. Photo: QDAFF

### Run-off capture and re-use infrastructure

Harvesting run-off/tail-water for use in irrigation is an effective way to reduce the discharge of pollutants into downstream waterways. It is an important treatment element where interception and storage is feasible and would not cause other environmental issues (e.g. rising groundwater problems, preventing natural water flows to existing wetlands etc.). In the dry tropics region, run-off capture and re-use on the farm can be a very effective pollutant removal design response and water efficiency measure.



Capture and Re-use Infrastructure. Photo: Evan Shannon

## Selection of appropriate run-off treatment elements

The selection of appropriate run-off treatment elements requires an understanding of both the local and regional landscape contexts.

### Assessment of regional scale opportunities

An understanding of the farm's location in the landscape is important when developing a run-off treatment train for a site to:

- identify water flows and natural wetland features
- ensure that any treatment elements are not in conflict with broader regional objectives.

This should also identify if there are any better opportunities for locating the more costly treatment elements such as constructed wetlands within the broader catchment or region. For instance, a constructed wetland receiving run-off from multiple farms may be a more cost effective way of treating run-off.

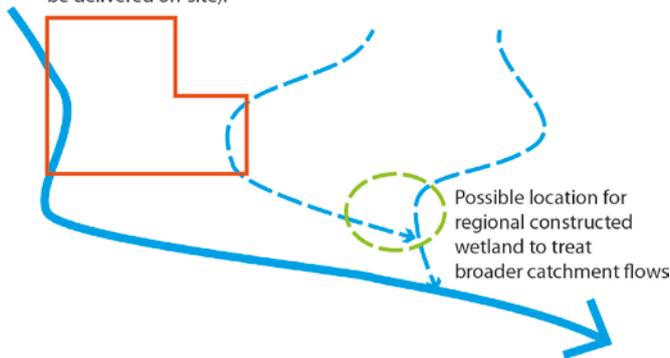
The following process will help to identify treatment elements applicable at a regional scale:

1. Identify if there are regional priorities identified in catchment plans such as Water

Quality Improvement Plans. The first point of contact is your local NRM group.

2. Assess the site conditions to identify what the opportunities are on-site that are not in conflict with any regional plans (see next section).
3. Liaise with relevant authorities (such as the local NRM group) to identify possible regional opportunities which can be delivered in lieu, or in conjunction with on-site systems, particularly if there are site constraints.

Individual site location within broader catchment context (on-site best management practices and coarse pollutant removal should be delivered on-site).

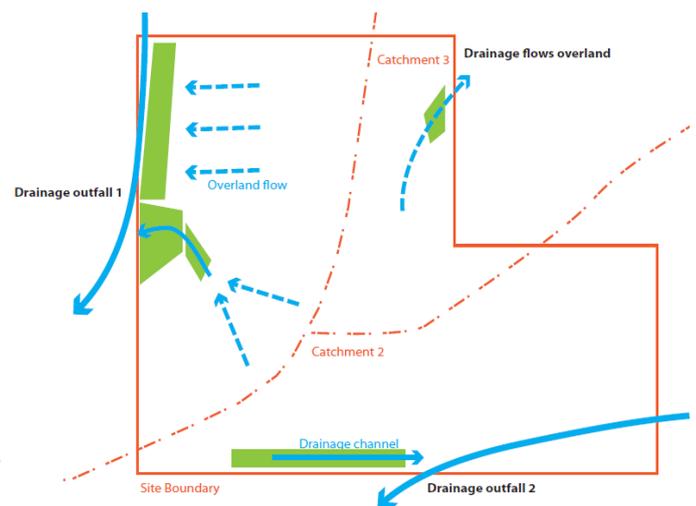
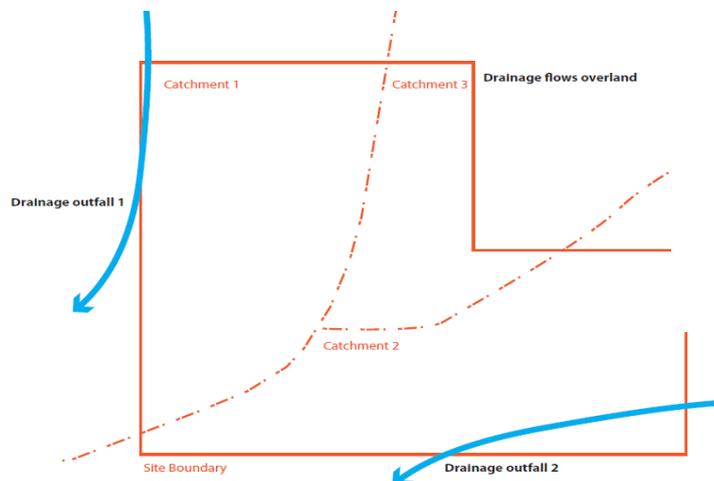


## Assessment of site suitability to support run-off treatment elements within the farm

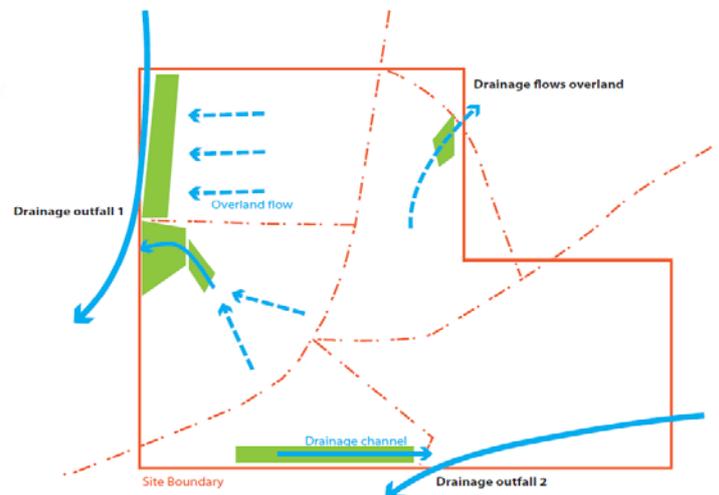
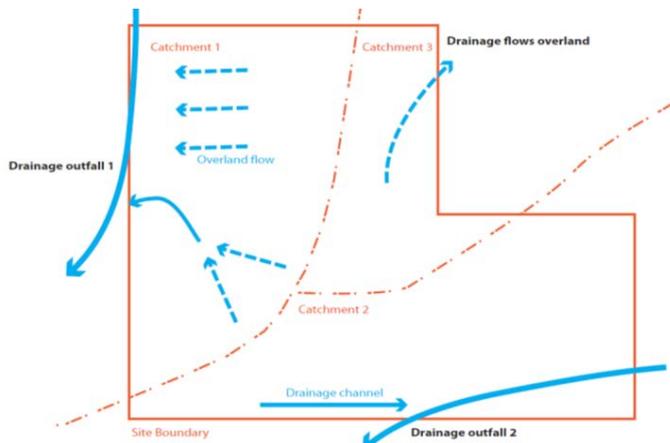
Not all of the run-off treatment elements presented in this factsheet are suitable for every site. Appropriate measures should be selected by matching the characteristics of the treatment element to the target pollutants and the physical constraints of the site.

The following process will help to identify treatment elements for a particular site:

1. Identify where the farm is located and how the catchment above the farm operates including high flows, flood, breakouts etc.
2. Within the farm identify where the site drains to and the catchment areas for each of the drainage outfalls.



3. Identify the location and type of drainage paths within each catchment of the farm (e.g. overland flow or drainage lines).
4. Identify the location and type of spaces available where treatment elements may be located. This will include identifying site characteristics which may influence the suitability of different treatment elements, such as existing vegetation or wetlands/waterways, grade and soil types.



5. Define the subcatchments associated with each of these areas in terms of pollutant types and area being mindful of the areas outside the farm.

6. Identify suitable treatment elements for the locations given the site and catchment characteristics (Tables 1 and 2 may assist).

Table 1—Comparison of treatment performance, relative cost, complexity and potential for capture and re-use of run-off for farm run-off treatment elements (adapted from Townsville City Council WSUD as Best Management Practices Fact Sheet - available at [www.townsville.qld.gov.au](http://www.townsville.qld.gov.au))

Run-off Treatment Element	Pollutant removal			Cost/m <sup>2</sup>	Complexity (design and construction)
	Coarse pollutants/ sediment	Nutrients (N and P)	Pesticides		
Buffer strip	M/H	M	M	M	L
Vegetated drain	M	L/M	L/M	L	L
Vegetated swale/drain	M/H	M	M	M	M
Sediment basin	H	L	L	L	L
Constructed wetland	L	H	H	H	H
Run-off capture and re-use infrastructure	M/H	M/H	M/H	M/H	M

H-High; M - Medium; L - Low

Table 2—Site constraints for farm run-off treatment elements (adapted from Townsville City Council WSUD as Best Management Practices Fact Sheet - available at [www.townsville.qld.gov.au](http://www.townsville.qld.gov.au))

Run-off treatment element	Steep site >4%	Flat site <0.5%	Shallow bedrock	Acid sulfate soils	Low permeability soils (e.g. clay)	High permeability soils (e.g. sand)	High water table	High sediment input	Limited space available (e.g. small compared to catchment)	Large contributing catchment
Buffer strip	x	✓	✓	✓	✓	✓	✓	□	□	x
Vegetated swale/drain	□	□	□	□	✓	✓	□	□	□	x
Sediment basin	□	□	x	□	✓	□	□	✓	✓	□
Constructed wetland	x	✓	□	□	✓	□	□	□	x	✓
Run-off capture and re-use	□	✓	x	□	✓	□	□	□	□	✓

x - Constraint likely to preclude use;

□ - Constraint may be overcome through design (although this may add costs and complexity to the design);

✓ - Generally not a constraint

## Further information

This fact sheet is part of a series on run-off treatment systems, as listed below. The Wetland Management Handbook provides more detail on treatment structures and general farm management to improve water quality leaving farms.

These resources and other wetland management tools and guides are available at <http://wetlandinfo.ehp.qld.gov.au/wetlands/management/wetland-management/>

Number	Publication Title
Fact sheet 1	Farm run-off treatment systems— toolkit
Fact sheet 2	Buffer strips
Fact sheet 3	Vegetated swales and drains
Fact sheet 4	Sediment basins
Fact sheet 5	Constructed (treatment) wetlands

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The Queensland Wetlands Program supports projects and activities that result in long-term benefits to the sustainable management, wise use and protection of wetlands in Queensland. The tools developed by the Program help wetlands landholders, managers and decision makers in government and industry. The Program is a joint initiative of the Australian and Queensland governments.

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or visit [www.wetlandinfo.ehp.qld.gov.au](http://www.wetlandinfo.ehp.qld.gov.au)

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