



## Nutrients - nitrate

### Edge-of-field nitrate reduction with woodchip bioreactors

#### Handouts

1. CAREX Key Steps
2. Aquatic weeds
3. Sediments
4. Nutrients - nitrate
5. *E.coli*
6. Rebattering

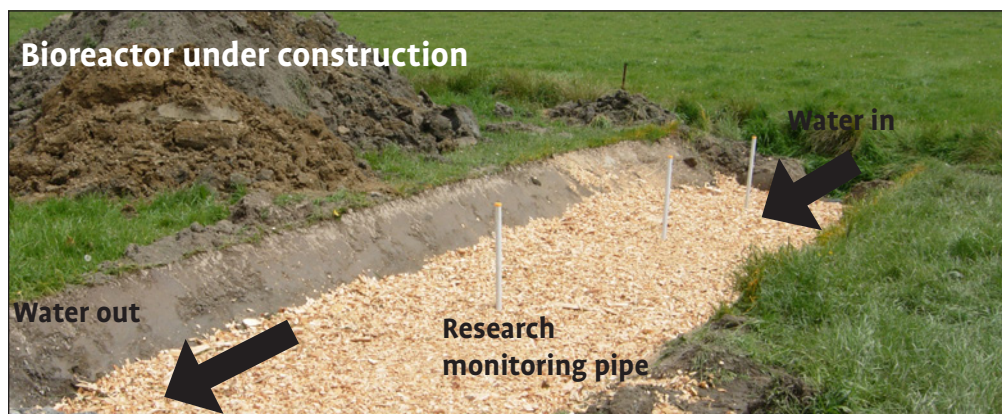
High levels of nutrients degrade water quality, increase algal blooms and aquatic weed growth. Elevated nitrate levels are an indicator of pollution and can pose a risk to human health. Nitrate mostly enters waterways from groundwater and sub-surface drainage water, such as tile drains.

**Bioreactors** are a tool used to reduce nitrate levels in water flowing into waterways that bypass riparian buffers.

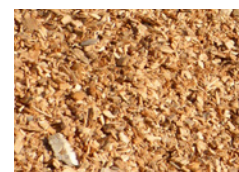
**How do bioreactors work?** Bioreactors provide a carbon source (often wood chips) and a suitable low-oxygen conditions for microbes to convert nitrate to nitrogen gas, in a process called denitrification. Nitrogen gas then enters the atmosphere and is harmless.



#### Bioreactor under construction



**Why woodchips?** A practical, affordable, sustainable & long-lasting (10-15 years) carbon source. Untreated woodchips either hardwood or softwood, ~ 2.0cm in size (to avoid compaction when in bioreactor), are best.

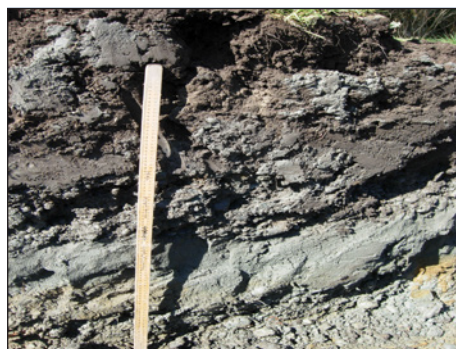


**On-going research & future trials** Early results from our bioreactor trials in Canterbury are promising, with an average of 10% reduction in waterway nitrate levels. To make a difference to water quality, edge-of-field tools to enhance nitrate removal must be complemented by land-based nutrient management practices.



# Step by step - Building an edge-of-field bioreactor

You'll need to combine information about your farm with input from experts to get a bioreactor up and running.



**1. Design & planning** - Consider several on-farm factors in design (see below). Careful planning is essential for operational success. Source woodchips.



**2. Site preparation** - Earthworks to dig the bioreactor pit. Lining the bioreactor with geotextile fabric depends on the heaviness of soils.



**3. Plumbing** - Install pipes and connect bioreactor to inflow, outflow and overflow structures, as required.



**4. Woodchip addition** - Digger fills in bioreactor with wood chips.



**5. Bioreactor cover** - Depending on soil type and other local conditions, a geotextile cover should be installed, especially if farming will continue over bioreactor. Top the bioreactor with soil.



**6. Monitoring & maintenance** - Check inflow structures and piping in winter/spring with higher flow. Maintenance will be site-specific and vary from year to year. Woodchips will need to be replaced after 10-15 years.

## Some bioreactor design considerations

- *Design type* - what is the source being treated (e.g., tile drains, open drains)
- *Size* - scaled to match nitrate load and water flow; 10-20m<sup>3</sup> is minimum recommended size to treat tile drains
- *Hydraulic residence time* - to allow sufficient contact time between nitrate-laden water and denitrifying microbes in the bioreactor
- *Slope* - inflow control structures to reduce back up of tiles, flooding or ponding in paddock
- *Soil type* - to line or not to line inside bioreactor
- *Drainage* - flow and nitrate load; high flow and low flow situations to design necessary diversions
- *Tile drains* - location, tile depth, diameter, slope, tile connectivity
- After bioreactor installation, paddock can be returned to productive land

There is still much to learn about this promising and practical low-cost tool making a difference in water quality in agricultural drains. CAREX research suggests a combination of nitrate removal tools, located at the edge-of-field (bioreactors), in the riparian zone (rebarrier and plant banks), or in-stream (organic matter addition), is likely needed to improve water quality. In some waterways, a two-stage channel may also be suitable. Many of these tools work by slowing down water and increasing the contact time of water with a carbon source or substrate.

**For more details and steps to get you started, please check out our other handouts.**