SOUTHLAND GRAVEL PITS CONVERSION TO WETLANDS: A WIN-WIN FOR FARMERS AND THE ENVIRONMENT

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Abstract
In certain areas of Southland gravel is extracted from below the top soil for on-farm use. Gravel is extracted down to the groundwater level (or just below), leaving open pits, frequently with open water areas. With a lack of suitable material at hand to re-fill them, they are often left as open pits. The feasibility of developing them into wetlands is currently being investigated by Environment Southland with advice from NIWA.

Constructing wetlands to reduce nutrient losses from farmland to natural waterways has a number of hurdles. Firstly there is the excavation cost as well as loss of potentially productive land. Another barrier to uptake of this technology may be the farmer having undertaken great efforts to drain wetlands on their farm. However, with dis-used gravel pits, the excavation costs are minimal and the farmer has already accepted the loss of grazing land at that location. Thus cost to achieve this conversion are much lower than constructing a wetland from scratch, with potential environmental benefits if such a pit can be connected to existing farm drainage systems resulting in a win:win for farmers and the environment.

Potential environmental benefits are reduced losses of sediments and nutrients from farmland to natural waterways, and providing locations for the protection of natural biodiversity. The level of treatment these systems might provide depends on their size relative to the drainage catchment feeding them. The NZ Guidelines for constructed wetland treatment of tile drainage (Tanner, Sukias et al. 2010) gives likely levels of treatment for wetlands occupying between 1% and 5%. If the gravel pit/wetland is smaller than 1%, it is unlikely to give substantial benefits with regards to removing dissolved nutrients. However they may still provide effective removal of suspended solids. In addition, if they are developed in an appropriate manner, they will provide biodiversity benefits. Thus it was recognised by Environment Southland that assessing the benefits of such systems will require a more holistic approach than simply measuring inflow and outflow water quality.

Key steps

Connection with farm drainage system, and flow distribution.

Inflows from the drainage system should be routed into one end, with outflow at the opposite end to encourage effective flow distribution and prevent short-circuiting. This ensures maximum potential for sediment settling and nutrient transformations. Deeper pools at the inlet slow water velocities and helps flows to distribute evenly across the width of the wetland. These can also be effective "flow collection points" near the outlet to assist collecting flow evenly across the width of the wetland. In general the outlet from the gravel pit/wetland should not be perched in a way that prevents fish access. While NZ native fish

have some climbing ability, they are unable to jump into an outlet pipe which may be suspended only a few centimetres above the receiving water level.

Retaining sufficient water in gravel pit/wetlands during dry summer periods should also be considered. If excavation has reached depths into unconfined gravel aquifers, there may be water present year round. However if the gravel pit dries out entirely during the summer, it is likely only the most hardy wetland plant species will survive, particularly in the first season after being planted when rooting depth will not be great. Thus planting should be timed with this in mind. If the pit stays wet throughout summer, then planting in spring will give plants the maximum time to establish before winter arrives. However, if the pit is known to dry out in summer, planting should wait until after water starts to appear again in early or mid-autumn.

Variety of available water depth.
Wetland plant species have different preferences with regards to water depth. Gravel pits with areas of different water depth encourage a diverse range of emergent wetland plants. Note that several emergent plant species will eventually grow down to depths of ~1.3-1.5 m, so if open water areas are desirable, then either ongoing plant management (every 2-3 years) will be required, or choosing only shallow growing species, or intentionally excavating the pits to greater depths will be required. By using a range of different plant species within a wetland, it provides greater biodiversity not only for the plants themselves, but also for native invertebrates, birds and fish which may have access to the site.

Sediments will tend to accumulate in deeper areas, thus some consideration should be made for sediment removal after a period of some years. This may entail retaining points of access for heavy machinery.

Selection of diverse water-edge species.
There are a wide variety of native wetland plant species that fringe lakes and wet areas. These can handle occasional inundation. By selecting a variety of species which are known from the locality (either previously or currently), the chances of successful plant establishment are enhanced, and a diverse and aesthetically appealing environment is provided. In general eco-sourced[1] native plants are recommended.

Selection of appropriate vegetation for dry marginal zones.
In areas on the dry margins further from the water's edge, various taller plants and trees can be planted. These may occasionally drop branches into the edges of the wetland, which are an important food for invertebrates as well as a habitat for both invertebrates and native fish. In addition, many native (and non-native) tree species provide food for native birds and bees as well as enhancing the aesthetic appeal of a site.

Fencing. Where a gravel-pit site is converted into a wetland, it will be important to exclude stock to prevent grazing and trampling damage to the plants and associated wet areas.

[1] Eco-sourced plants have been collected from the local area, and may have regional differences to those from other areas. In addition, plants which have been successful in a location for hundreds or thousands of years are more likely to successfully establish than those that are successful in Northland for example.

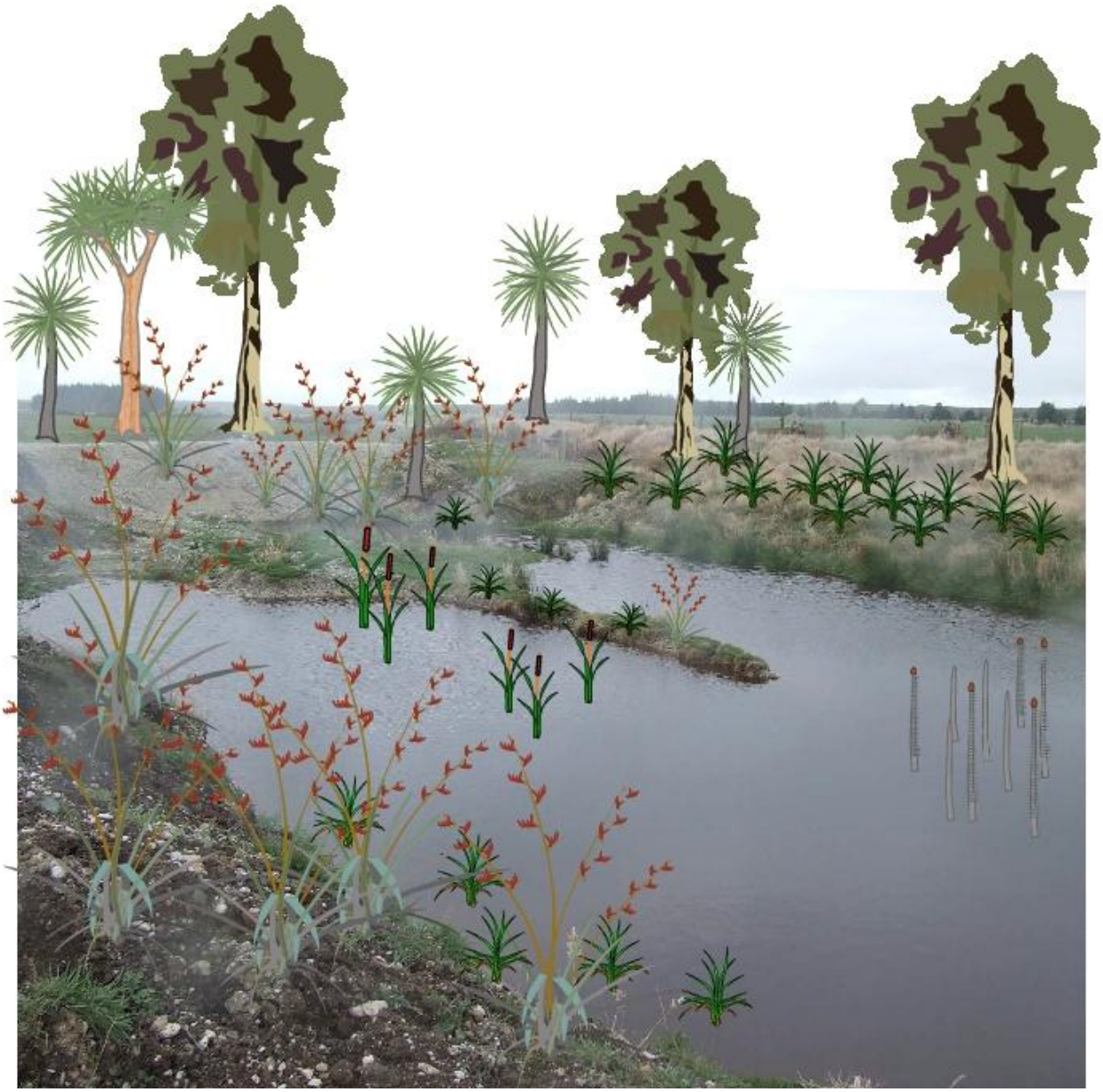
A Southland Example

The following example is a gravel pit on a Southland farm with suggestions as to ways to utilise it as a wetland.

Flow from an adjacent surface drain had been directed through it, with an outflow at the far end of the photo above, effectively utilising the maximum potential of the wetland/pond volume.

As can be seen, at the present water depth and area in the middle of the pond is virtually an island. Many duck species prefer nesting in habitats such as this which deter predators. Thus at the time of excavation, awareness of this possibility could have created a valuable wetland feature. In addition the banks are quite steep. If they had been excavated with a shallower gradient, wet margins of the wetland would have been enlarged, providing the opportunity for greater planting diversity.

The following illustration shows the potential to provide planting which enhances the biodiversity values of this site.



Some recommended species

Deep water emergent
Eleocharis sphacelata (kuta). Main deep water species for Southland

Wet margins
Astrodieria richardii
Carex secta (purei)
Carex virgata (pukio)
Chionochloa rubra (red tussock)
Cordyline australis (ti kouka, cabbage tree)
Eleocharic acuta
Phormium tenax (harakeke, lowland flax)

Dryer margins
Astrodieria richardii
Coprosma propinqua
Dacrycarpus dacrydiodes (kahikatea)
Leptospermum scoparium (manuka)
Sophora microphylla (kowhai)

Summary

Farmer benefits include:
On-farm attenuation of solids and nutrients which creates a more sustainable farming solution.

Costs for construction are much lower than for a standard constructed wetland, as excavation already undertaken.

Loss of grazing area already included in farmer decision-making process.

Environmental benefits include:
Solids captured by settling.

Nitrogen removed by denitrification.

Phosphorus attenuation by settling and plant uptake.

Biodiversity islands (or stepping-stones) present in an otherwise highly developed agricultural landscape.

Aesthetic benefits by providing an attractive farm feature.

While this work has thus far been a feasibility study which might be used to guide farmers into converting their disused gravel pits, discussions with local agricultural contractors has already identified a willingness on their behalf to undertake gravel excavations with future conversion into a wetland/pond system as one of the goals at the start of the extraction procedure.

References

Tanner, C.C., Sukias, J.P.S., Yates, C.R. (2010) New Zealand Guidelines for Constructed Wetland Treatment of Tile Drainage: 54. http://www.niwa.co.nz/our-science/freshwater/tools/tile-drain-wetland-guidelines