Surface Water Management On The Farm

PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

A Landholder's Perspective

A Partnership Project of the Peel-Harvey Water Quality Improvement Plan, 2010-2011.

Introducing

Neil Kentish
Beef, tree and water farmer

"During the late 1960's when I was 16-17 years of age my father Lance had me digging out a trench on both sides of the banks of the Karnet creek running through our Serpentine property with a mattock, crowbar and shovel. A big red gum had fallen over in the paddock during a storm and Dad had cut the stump and the "tops" off the log. We dragged it into the creek by using two tractors, chains and wire cables, and a lot of effort. The ends were positioned into the trenches I had dug, and the log was levelled and was to become the base of a crossing for the cattle and tractors."

Neil Kentish of Mount View in Serpentine has practiced 'water harvesting' on his properties since the 1950's, when they were used primarily for dairy farming. This practice has taken many forms over the years, from using paddock grades to guide water to drier areas, to installing contour banks on sloping land, and planting tree species for timber and other products. The reasoning behind all of these practices has been to keep, and use, water on the farm. *"Turning water into wood"*, as Neil calls his tree farming enterprises, means the run-off from the tree planted paddocks is practically negligible.

The principle of slowing down and making use of water has also been, for many years, applied by the Kentish's to the creek lines running through their properties. If cattle and other stock are allowed to utilise the bed and banks for grazing, drinking and 'camping', farm streams can become degraded over the years. This results in less and less riparian vegetation, which in turn causes increased erosion of the banks, incision of the channel, and increased velocity of water flow. For many years, Neil has strategically placed logs along the creek banks, successfully slowing down the water flow in places and raising water levels by up to 1.5 m.

Taking this a step further, rocks and broken stone have been utilised in the areas of creek line most affected by erosion. This has had the multiple-benefit result of protecting banks from further erosion, slowing down the flow of water by roughening the surface over which it flows, and providing in-stream habitat for aquatic fauna that has been lost over the years.

Neil's reasoning behind keeping and using water on-site goes beyond improving productivity of pastures and other agricultural land uses. This is reflected in his actions to increase native habitat value in strategic areas of his properties, including fencing and revegetating creek lines, and returning a drained paddock to a vegetated wetland.

More information about Neil's land use practices and on-ground projects can be accessed in publications "Best water management practice carried out by farmers within the Peel-Harvey Catchment" and "Wetlands creation in the Bassendean sands of the Swan Coastal Plain" *(*Angell, 2001; Landcare SJ Inc., 2006) or by contacting the Serpentine Jarrahdale Community Landcare Centre. *(See back for details)*

Use of grade banks at the paddock scale for surface water management

In 2010, Neil Kentish had been considering constructing a series of grade banks in a problem paddock to reduce the risk of erosion and reduce downstream nutrient loads by slowing the velocity overland from the upstream catchment.

A man who always has a new idea floating around in the back of his head, Neil took advantage of the opportunity to receive funding, technical advice and support from the Peel-Harvey Catchment Council's and Department of Water's partnership project 'Filtering the Nutrient Storm', funded by the Western Australian Government's State NRM Program. The following project outline is adapted from a case study put together by Hydrologist, Matt Giraudo.

Flow generated from the upstream catchment discharges under Hall Road and then across Neil's paddock to the Karnet Creek, a feeder tributary of the Serpentine River.

The upstream paddock has a slope of approximately 1-1.5% (1 m fall over 100 m), and concentration of flow has previously resulted in erosion and the formation of a minor gully.

As a result, flow discharging under Hall Road contains sediment, transporting nutrients, in particular, phosphorus, to downstream environments.

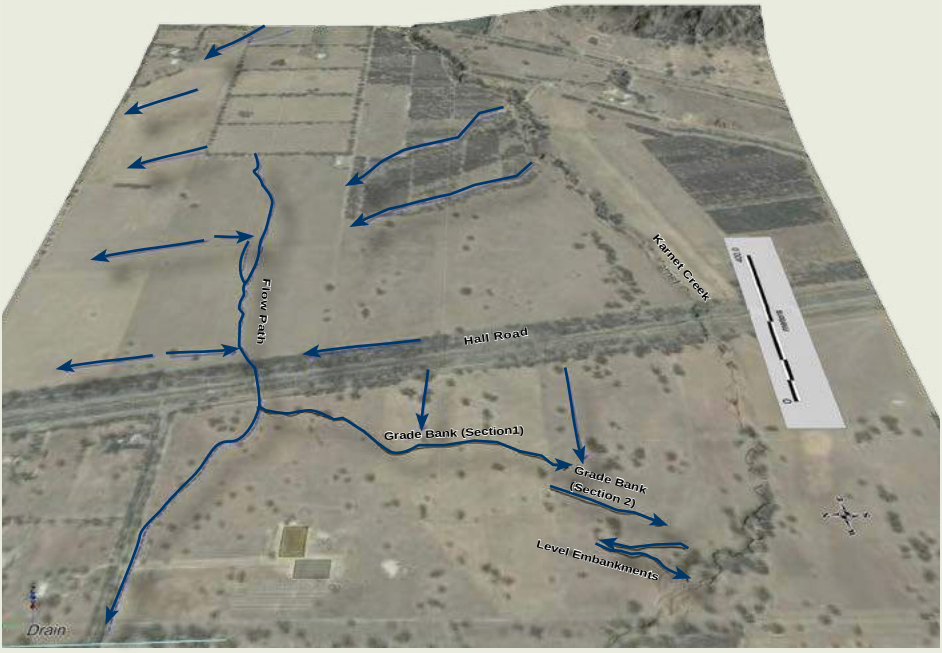

Figure 1: Aerial view of project site.

The problem

Management of flows at a paddock scale is important in reducing nutrient discharge to the Peel-Harvey Estuary.

The upstream catchment of the project site is estimated to be approximately 100 ha with a slope of approximately 1%. Flow is discharged to a culvert under Hall Road and the adjacent railway line. It is estimated the catchment generates approximately 56 million litres of flow per annum, assuming an annual run off coefficient of 0.07 (ie. 7% of rainfall ends up as run off).

Section of the flow path.

During relatively small flows, (say a 1 in 2 year event) the velocity of runoff will exceed approximately 1.0 metre per second and will potentially result in paddock erosion. A 1 in 10 year flow event is almost certain to result in significant erosion of the flow path, with the velocity approaching 1.3 metres per second.

The design

In designing any earthworks it is important to ensure that the design and survey are carried out properly to ensure that the bank has sufficient capacity, is constructed on the correct grade (slope) and has an even gradient. Neil determined that to address the flow problems outlined above, the proposed bank needed to be approximately 800 m long. Grade banks are typically less than 1.5 km in length, reducing the risk of overtopping the grade bank due to accumulation of flow during large rainfall events.

Grade banks are typically surveyed using a slight grade to ensure water does not build up behind the bank. The bank for this project was surveyed to have a gradient of 0.2% - 0.25%, (a drop of 40-50 mm over 20 m).

The project's grade bank was designed to intercept flows immediately downstream of Hall Road and direct the flow south towards the Karnet Creek. There is a break in the grade bank approximately 580 m along its length, due to a small patch of trees. Rather than remove the trees, flows have been allowed to discharge over the end of the grade bank, and are then picked up by a second section of grade bank approximately 180 m in length.

Flows discharge from the second grade bank into two level banks forming terraces of approximately 110 m in length prior to discharging to the Karnet Creek. This section of level bank immediately upstream of the discharge point is designed to further slow the velocity of the surface flow, thus encouraging any remaining sediment to drop out prior to entering the creek (Figure 1).

The construction

Neil began construction of the grade bank using a disc plough. Disc ploughs are commonly used to construct grade banks on low to moderate sloping land, provided the soil is sufficiently friable. The soil from the channel is typically placed on top of the bank.

Soil should be moist when constructing grade banks, with ideal moisture content similar to that required for sowing a crop.

Graded bank construction, May 2011.

In some situations grade banks can be constructed during drier conditions, particularly when using a plough. Running a tractor or grader tyre along the side of the grade bank during construction will help consolidate the bank, particularly if the soil is relatively dry. Cultivation of the soil either side of the grade bank prior to construction is also a common practice to assist in creating sufficient loose soil with which to construct the bank. Where possible, grade banks should be constructed with a relatively flat broad channel, located on the up-slope side of the bank. The channel should be maintained as a grassed waterway to reduce the risk of scouring.

Before construction, Neil removed stock from the paddock to reduce the risk of trampling prior to the settling and grassing over of the newly constructed bank. Stock will be excluded from the area for approximately 2 months, during which time Neil will also 'tidy up' the banks with a grader.

The channel of the grade bank should be cleared of debris every 5 to 6 years, in order to minimise obstruction and maintain the bank's capacity.

The impact

Nutrient concentrations of surface water flows in the project area are likely to be in the order of 0.25 mg/L of total phosphorous (TP), however nutrient concentrations will vary throughout the year depending on timing of fertiliser applications and severity of storm events. Assuming an average TP concentration of 0.25 mg/L, a saving of approximately 4.5 kg per annum (TP) can be obtained after grade bank construction.

Nutrients are likely to be predominately in particulate form (attached to the suspended sediment). Subjecting flow to the level, vegetated embankments prior to discharge to the Karnet Creek will further help reduce sediment and therefore nutrient concentration of discharge.

It is estimated that construction of the grade bank will reduce the flow velocity of a 1:10 year peak flow from approximately from 1.3 m/s to 0.66 m/s.

This will reduce the likelihood of erosion and encourage the settling out of the coarse sediment collected upstream. Grade banks can be considered nutrient traps, causing sediment to settle out as a result of a reduction in the velocity of the flow.

Paddock grading July 2011.

Revegetation

The grade banks in this project will significantly reduce velocity of overland water flow, resulting in reduced erosion and increased settling of sediment and nutrients. Revegetation augments the banks so that the final state of the earthworks goes beyond the advantages of man-made structures, to one which also harnesses the characteristics of the natural landscape. In this way, revegetation has achieved significant value-adding and, thus is an important step in the process to achieve the desired outcome of reduced nutrient runoff. Neil had a number of choices in regard to the type of vegetative cover over section 2 of the grade banks and level embankments adjacent to Karnet Creek.

1. Pasture

Whether left for re-germination with volunteer species, or re-sown with desirable species, the project site can be left under pasture and remain a part of the farm grazing system. Use of perennial pastures such as Rhodes grass and kikuyu has the following advantages:

- They are more likely to provide year round cover due to their deep root systems that allow them to stay green later in spring than traditional annual pastures, and to make good use of occasional summer and early autumn rainfall.
- Perennial pastures also have the ability to intercept nutrients leached below the shallow root system of annual pastures and to use nitrogen produced by annual legumes (Angell, 2007).

2. Local native plant species

Neil chose to revegetate the area using local native species. That is, plants that would have grown at the site prior to clearing for agriculture. In its purest form of an uncleared landscape, the over-arching advantage of vegetative cover is that there are no interruptions to the hydrological cycle. The vegetation reduces raindrop impact, and improves the percolation into the soil. Rainfall is taken up by the leaves of the plants with the remainder entering the ground sub-surface, where it is utilised by the roots of the vegetation. There is hardly any run-off of precious moisture or excessive nutrients, resulting in little waste.

Land management practices can go a long way towards mimicking the characteristics of a more vegetated land surface, resulting in a healthier, more productive landscape. The advantages of vegetative cover are augmented by Neil's choice to strategically place particular species where they will be most useful. The overall revegetation plan resulted in sedges being placed between the banks, where the water flows. A mixture of local tree and shrub species were placed on top of the embankments, (See Figure 2) .

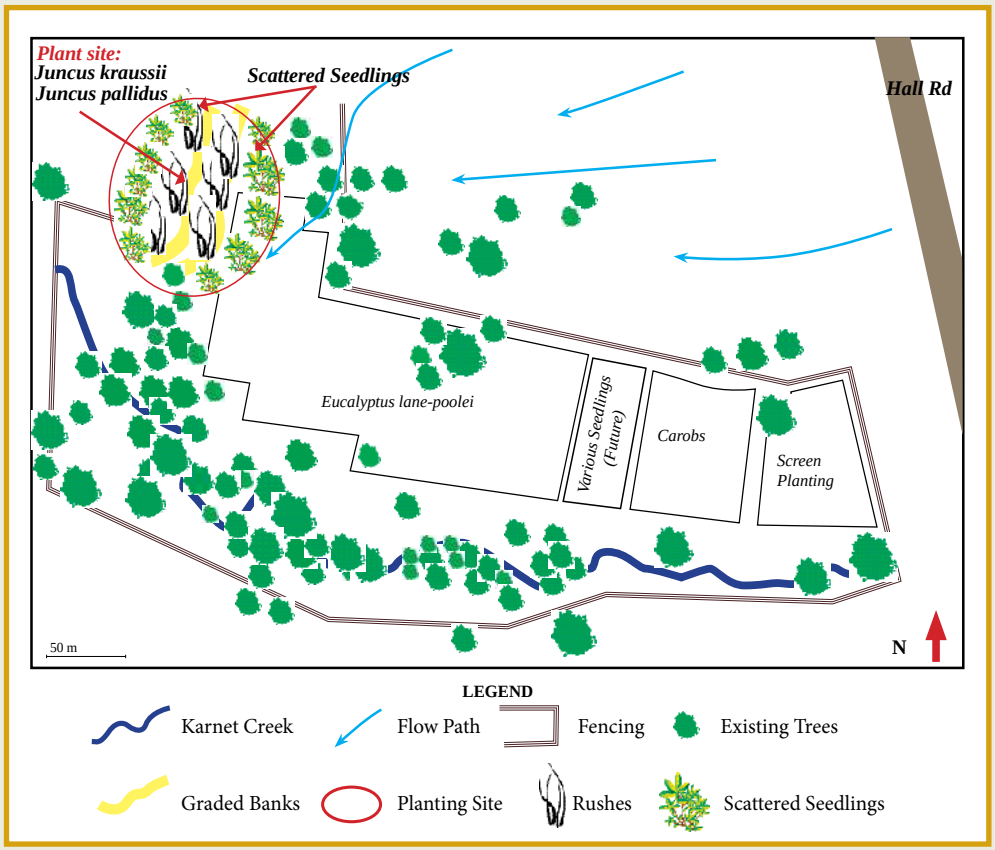

Figure 2: Mud map of planting.

Sedges and Rushes

Sedges and rushes are grass-like species that grow in wetland environments. Many are native to South West, Western Australia, and can tolerate some dry conditions, due to a large degree of our wetlands being seasonal in nature, that is, characterised by being inundated in winter and drying out in summer.

Sedges and rushes have laterally spreading stems close to the ground surface that are extremely effective in binding the soil together, thereby reducing water velocity. This, in turn, reduces erosion and causes sediment to drop out of the slow moving water. For this reason, they make perfect buffers between waterways and adjacent land prone to runoff and erosion, as the nutrients associated with sediment are also stopped in their tracks.

But it does not stop there!

Once the nutrients have been trapped, these plants can uptake them through microbial processes in the rhizosphere of the plant.

Two local species of rush were chosen for the project site:

Juncus pallidus (Pale rush)

A robust rush that grows to 2m and forms very dense clumps. This species has rhizomes (underground stems) that cause it to spread of its own accord, and it is thus considered a vigorous coloniser.

Juncus kraussii (Sea rush)

A tough rush that grows to 1.2m and is considered an ideal stabiliser. This species also has rhizomes and thick roots with hairs.

Juncus pallidus, photo by Eddy Wajon

Juncus kraussii, photo by J. Garvey

The presence of rhizomes in these Juncus species augments their ability to accumulate and assimilate nutrients. This is due to the high surface area provided by the dense rhizomatous mass. This dense underground structure also provides excellent micro-habitat for invertebrate aquatic fauna, as well as vigorous competition against unwanted weed species.

Native trees and shrubs

Terrestrial native vegetation provides a similar but less robust ability to filter nutrient-laden surface water running off from adjacent paddocks. Once their roots are established, they contribute to slowing water velocity, particularly subsurface water. Once again, this reduces the erosive capacity of the water and causes it to release any nutrients that it may be carrying. Their roots also bind the soil together and assimilate nutrients, though less so than sedge species.

Native vegetation provides excellent habitat for native fauna species and effective shading for ongoing weed control. The strategic nature of the revegetation along the creek line and embankments will also increase the inter-connectedness of the landscape in terms of wildlife corridors. In particular, the creek line vegetation will join up with the roadside vegetation corridor along Hall Road.

The general rule for revegetating with local native species is to use 10% tree species and 90% shrubs and ground covers. This mimics somewhat, the proportion of growth forms in natural bushland.

Species list

42-50 mm tube stock seedlings were ordered from a local nursery. Small seedlings are necessary to avoid the problem of more mature seedlings not being able to cope in the natural environment. By planting seedlings at a young age, the 'hardening off' process occurs in situ, which contributes to a greater survival rate of seedlings.

Species planted:

Botanical Name	Common Name	Qty
Juncus kraussii	Sea Rush	5000
Juncus pallidus	Pale Rush	5000
Acacia pulchella	Prickly Moses	60
Astartea fascicularis	No common name	70
Eucalyptus rudis	Flooded Gum	70
Kunzea ericifolia	Pondil	70
Melaleuca preissiana	Freshwater Paperbark	70
Melaleuca rhaphiophylla	Swamp Paperbark	70

Site preparation

Revegetation of a 'blank canvas' involves a number of steps that are essential for success, which can be defined as at least an 80% survival rate of seedlings through the first summer, with some allowance for replacement of lost seedlings in the following planting season.

Chemical weed control of the planting area was carried out in May and June after the grade banks had been constructed earlier in the year.

Ripping attachment.

Once the cooler, moister autumn weather had caused weed germination, particularly on the newly cultivated soil, it was an ideal time to spray the weeds with an equal mix of knock down and residual herbicide.

Once the weeds had died off, the areas of paddock in between the banks that were to be revegetated were ripped using a tractor implement called a deep ripper that cuts through the soil to a depth of 60-70 cm.

Close-up profile of ripping process.

If done at the correct time, when the soil is just moist, ripping is effective in shattering the soil profile. This ensures water infiltration and aids in root penetration of the newly growing seedlings. This is particularly essential on land that has been grazed, due to the high level of compaction from years of human and animal traffic.

Planting

Planting took place in late July and early August 2011. This is an ideal time to plant native species so that they get plenty of rainfall for adequate root development before the onset of the first summer (assuming it is not a dry winter).

Getting them through the hot months is the key to ongoing survival of the seedlings. The more established they are by the end of spring, the better.

Sedges and rushes that require wet conditions also need to be planted in winter to establish adequate root systems prior to the onset of summer. Tree spades were used for digging planting holes for the seedlings along the rip lines and embankments, at an interval of 2-3 m. Sedges and rushes were planted at a density approximately 6-8 per square metre. The sheer number of seedlings that needed to be planted into the project site meant that Neil needed all the help he could get!

This came in the form of the Serpentine Primary school, who helped plant some 10,000 sedges and 200 assorted tree and shrub species on a rainy July day.

Help also came from 14 members of the Conrodders, a Hotrod club of which Neil is a member. 3,500 more seedlings from another funding source were put in by this group of volunteers.

Support for these planting days was also provided by staff from the SJ Landcare Centre, the Peel-Harvey Catchment Council and the South West Catchments Council.

Serpentine students get instructions, July 29th, 2011.

Planting underway, July 29th, 2011.

Finished product, July 29th, 2011.

All who assisted in the planting, July 29th, 2011.

Follow-up maintenance

In terms of the revegetation, the main follow-up maintenance required will be for weed control during peak germination periods in spring and autumn. An overspray of residual herbicide will be carried out in March 2012, followed by at least 2-3 years worth of further chemical control of unwanted species.

The revegetated area, including the stream banks and the newly constructed grade banks, will be permanently protected from stock by fencing that has been installed.

In-fill planting to replace any seedling losses will be carried out in 2012.

As mentioned, the rush species chosen have significant spreading capabilities due to the presence of rhizomes (underground stems). They are capable of spreading up to 1.0 m within 2 years, at which point vegetative division is possible to separate plantlets and carry out further planting if desired.

Part of the new fencing installed by Neil to stop access by stock to the vegetated areas (partly funded by the South West Catchment Council).

Conclusion

This project was made possible first and foremost through the finances, time and expertise contributed by Neil Kentish, who is committed to the natural environment and desires to see his section of the Karnet Creek "like it was 50 years ago". Further funding and expertise came from the Peel-Harvey Catchment Council and the Department of Water partnership project 'Filtering the Nutrient Storm', and the South West Catchments Council.

This project represents the implementation phase of the Water Quality Improvement Plan for the Peel-Harvey Estuarine System, funded by the Western Australian Government's State NRM Program.

The paddock scale project outlined in this booklet was carried out to address a catchment scale problem. The 'problem' plays itself out over and over throughout the Peel-Harvey Catchment, and is related to the transport of sediments and nutrients off properties and into waterways that eventually lead to the Peel-Harvey Estuarine System.

If partnership projects such as this one were similarly repeated throughout the catchment, the Estuary and rivers would be in much better shape.

Progress Snaps

Planting site, July 29th, 2011.

Planting site, November 15th, 2011.

Planting site, July 29th, 2011.

Planting site, November 15th, 2011.

Notes

References and Acknowledgements

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Acknowledgement to Matt Guirado (Hydrologist), whose case study provided the project outline for adaptation for the "Filtering the Nutrient Storm" project.

Funds to deliver this project were made available through the Government of Western Australia's State NRM Program, in partnership with the landowner Neil Kentish, Department of Water, and Landcare SJ Inc. The Peel-Harvey Catchment Council is delivering the Peel-Harvey Water Quality Improvement Plan Implementation Project – "Filtering the Nutrient Storm" through an agreement with the Department of Water.

For further information: www.peel-harvey.org.au

LANDCARE Serpentine - Jarrahdale SJ

PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

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