Project 4.4 : Prioritisation and effectiveness of rural land runoff control interventions

Assessing the performance of sediment ponds and swales at Beenak

March 2016

Background

Project 4.4, *Prioritisation and effectiveness of rural land runoff control interventions*, is assessing the performance of interventions undertaken within Melbourne Water's Rural Land Program that aim to protect rural waterways from pollution, erosion and degradation. The project commenced in 2013/14 with the monitoring of treatment measures at a cherry orchard on Beenak Road, Wandin North ('Beenak'). This site was selected as it provided a representative sample of treatments, other than revegetation, that might be used by the Rural Lands Program. The landowners also had an existing relationship with Melbourne Water and were supportive of the project.

Monitoring effort and results (to date)

Planning for Beenak began in November 2012, with five systems originally being identified for monitoring. Two of these were sediment ponds, constructed prior to the project's commencement (funded by MW incentives). The others were: an existing grass swale, a vegetated swale (constructed as part of the project) and a small wetland (Figure 1). Ultimately, only the constructed and grass swales were monitored for water quality, because (i) the main sediment pond trapped all flows, making it impossible to monitor, while the lower pond was too small to provide useful treatment.

For a number of reasons (discussed below) it took eight months to establish a working monitoring system for the grass swale and approximately twenty months for the construction, establishment and monitoring of the constructed swale. This swale had not been part of the original design for the property, but was deemed necessary by Melbourne Water and the research team for a proper 'best practice' treatment train at the site.

So far, data has been collected over 20 and 12 months for the grass and constructed swales respectively. In that time, eight events were recorded for the grass swale. The first six (when combined) tend to show a slight decrease in TSS, TP and TN (Figure 2a), however, the last two events collected show a reduction of TSS only and an increase in TN and TP (Figure 2b). This is likely a result of the overspray during the landholder's application of "High K" fertiliser.

Figure 1: Site map showing the location of treatments systems at the Beenak site.

There have been four events recorded from the constructed swale (Figure 3), with this site having some issues with preferential flow paths between and around the plants which caused a small amount of incision; this has been addressed with the application of "Rock Socks". At this stage the data are inconclusive and, consequently, we plan to monitor the swale for a further **five events** to ensure that we have data which provides a reasonably reliable overall indication of the swale performance.

This project is shifting its primary focus to monitoring interventions installed in the Tarago catchment, using the lessons of Beenak (see below) to ensure success. Limited monitoring activity will remain at Beenak to ensure enough data are collected to be confident in the overall results.

Other outcomes from the project include:

- Collection of reliable, high resolution rainfall data and inflow to the property, that may aid in the calibration of rural rainfall/runoff models.

- Design of a vegetated swale with potential for widespread installation on rural drainage lines.

Lessons for monitoring (in rural environments)

There are a number of lessons to arise from this project, most of which derive from the challenges faced at Beenak (see below). It is important to note that many of these issues are very difficult to avoid entirely (and indeed occur during most monitoring efforts), as monitoring in rural catchments is inherently difficult because runoff is less predictable than it is from impervious surfaces.

- When selecting monitoring sites, it is important to target catchments where there is minimal chance of hydrologic manipulation by other (upstream) landholders. Ideally, sites should have relatively predictable flows or good estimates of long-term flows and the effect of seasonality.
- Ideally, pilot (course resolution) hydrological monitoring should take place prior to the final site selection. Doing so will ensure there are sufficient flows available on site to monitor and allow for a more accurate design of monitoring program and equipment.
- Infiltration testing should accompany the pilot monitoring, especially where large volume sedimentation ponds or dams are involved.
- There needs to be a clear understanding between landowners and project team around the use of chemical use on land while monitoring is underway, ensuring effective two-way communication at all times.
- Clear identification of field monitoring equipment to avoid damage. This may require (expensive) protective systems around monitoring installation.
- We learnt that the installed runoff control interventions can retained more runoff than anticipated, which can affect not only monitoring but also reduces harvesting volumes for landholders. This is a valuable insight that can assist in the selection of runoff interventions, particularly in the Wandin region and areas with similar soils.

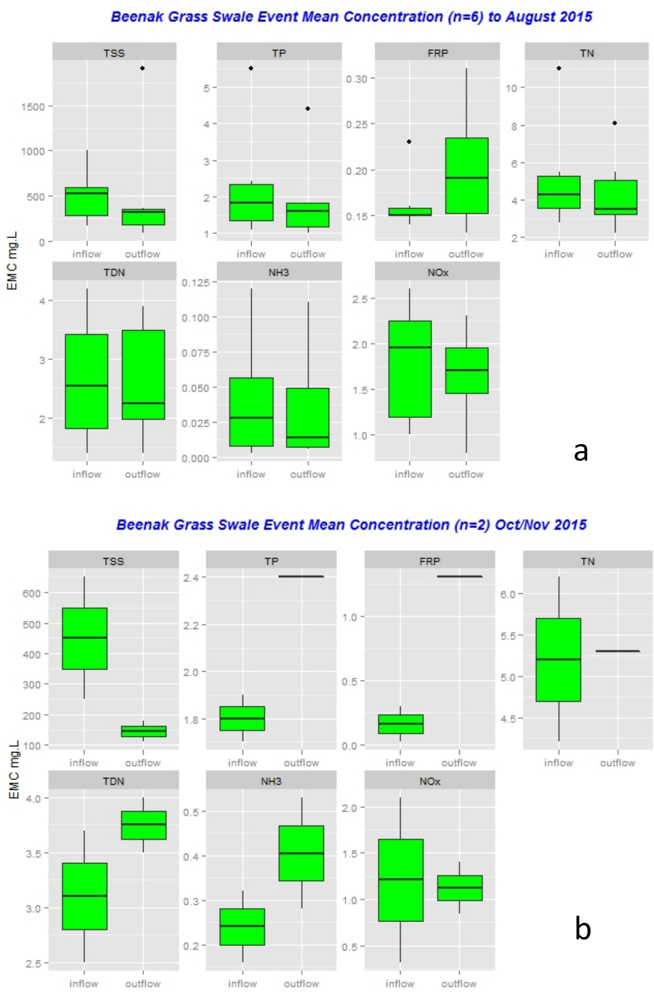

Figure 2: Mean concentrations from the grass swale for a) the first six samples which had unknown rates of fertiliser application, and b) two collections during which spraying was known to be occurring.

Challenges to monitoring to Beenak

As is commonly the case with monitoring in the "real world", the Beenak site presented a number of challenges to establishing a monitoring program, which has limited the amount and quality of data collected so far. Most of these derive from the design of the existing treatment systems, combined with the characteristics and locality of the property. These challenges, and their ensuing delays and resolutions included:

- **A lack of runoff**. Anecdotal evidence of changes in land and water use higher in the catchment (outside the property) resulted in an unprecedented reduction in flow to the monitoring site. Flows monitored during the study to date have been an order of magnitude lower than previously experienced when the landholders increased the size of their culvert to reduce frequent flooding.
- **High infiltration rates**. The very high infiltration rates (in the order of 100mm/hr) of the farm's soil and the top sediment pond (on the properties boundary) reduced runoff significantly. On those occasions when water did manage to reach the property, it was captured and infiltrated by the top sediment pond. For example, outflow from the top sedimentation pond occurred only twice over a three month period in winter 2013. A bypass was installed to resolve this issue, however this delayed the project by eight months.

- **Lack of background/baseline data**. With only anecdotal evidence of flows (i.e. estimated during wet conditions), it was difficult to accurately design a suitable flow monitoring program. Water was harvested from dams higher in the catchment which made the rainfall/runoff relationship of the catchment highly variable and, therefore, very difficult to design weirs and estimate sampler triggering volumes to obtain event mean concentrations of pollutants.
- **Owner operations**. Although the landholders have been and remain very supportive of the project, the need to continue running an operational farm leads to inevitable challenges. For example, there has been accidental damage from a mower to monitoring equipment (this occurred on several occasions), and periodic fertiliser application has impacted monitoring results. As a consequence, some data samples were compromised (the project team only became aware of the spraying when analysing water quality data).
- **Equipment communications**. The large distance between monitoring stations required the use of radio frequency switching to trigger remote sampling stations. Unfortunately, this technology increases the risk of failure. For example, two events were missed as ants shorted out the telemetry equipment.
- **Equipment failure.** Flow monitoring at Beenak relied heavily on a flowmeter in the culvert. Following a lightning strike the motherboard was destroyed (the landholder's coolroom refrigeration was also destroyed). We thus installed a weir to replace this flowmeter.
- **Project construction**. The construction of the vegetated swale presented two challenges. First, the project had to fit in with the owner's land use- car parking for their cherry customers. The solution was to slightly modify the design (a slight curve) to allow for the public car parking area. Secondly, and the most significant, was to control the flow conditions and significant time for the vegetation to establish. This delayed sampling until the end of 2014 when the vegetation was suitably established to perform the desired water treatment function.

Where to from here for Beenak?

As of March 2016, monitoring of the grass swale has now finished. Monitoring of the constructed swale is currently on hold for the moment until the landholder finishes applying fertilizer (by spray) on the farm, this is expected to occur sometime in April, at which point the project will allow a settling time and resume sampling the constructed swale; targeting 5 more events. The results below show inflow and outflow concentrations of TSS, TP and TN (as well as nutrient species) for the grass swale as well as the constructed swale at Beenak.

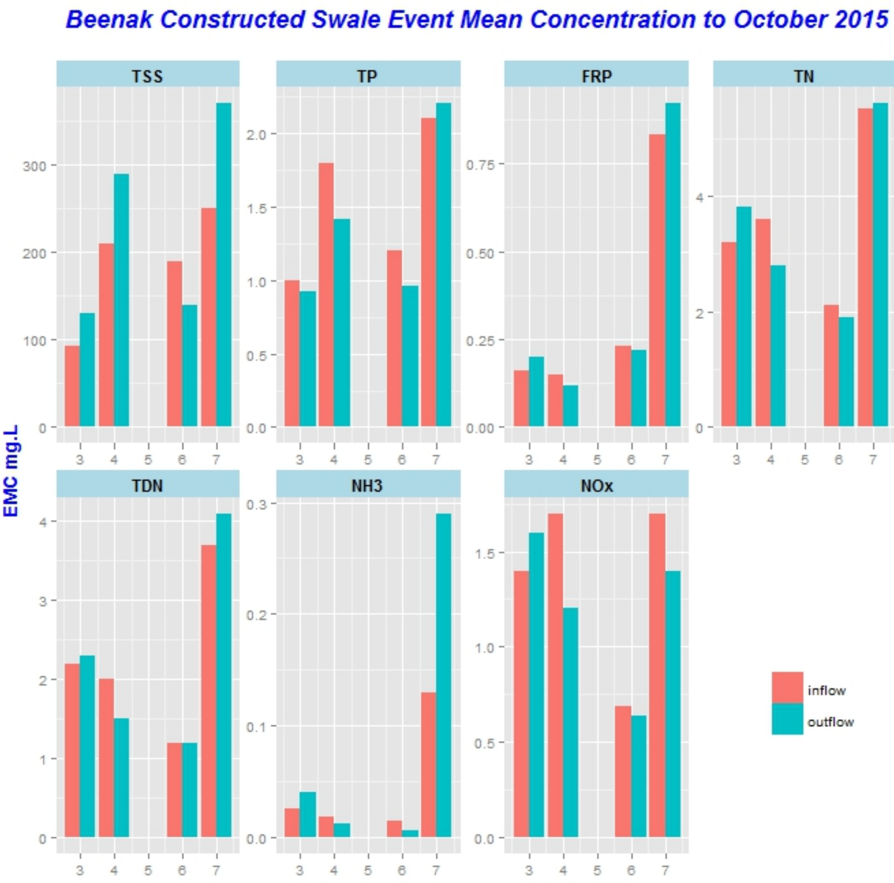

Figure 3: Mean event concentrations for the constructed swale.