SAWMILL STORMWATER MANAGEMENT

Mark Groves, Ben Melvin, Reagan Knapp, Opus International Consultants Ltd.

ABSTRACT (200 WORDS MAXIMUM)

This paper discusses the preliminary outcomes achieved through the re-development of a challenging existing timber sawmill site. Through improved site practices, modern structures, improved site drainage and provision of stormwater treatment genuine improvements to surface water and groundwater quality were achieved with the stormewater system in its temporary construction form. This paper discusses the stormwater treatment system itself, both its temporary construction form at the time of sampling and its final form which includes a low head sand filter and a combined surface/ sub-surface flow wetland designed to target dissolved metals.

KEYWORDS

Stormwater, Sawmill, Treatment, Wetland, Sand Filter, Source Control, Dissolved Metals

PRESENTER PROFILE

Mark Groves is a senior environmental engineer with over 17 years of experience spanning both New Zealand and the United Kingdom. His experience includes infrastructure design, hydrology, hydraulic modelling, low impact stormwater design and flood risk management.

1 BACKGROUND

As part of a motorway design project, it was decided that an alignment through an existing saw mill site would be the best environmental outcome for the project. This negated constructing two bridges over a river and would facilitate improvement of the existing saw mill site as it is reconfigured to accommodate the motorway corridor along its northern edge.

The sawmill site as it stood had poor drainage. It sits within the former floodplain of a major river and is still prone to backwater flooding from that same river. The site soils are deep silts which are poorly drained and depth to groundwater is shallow, with springs at one portion of the site and ponding water within its perimeter drain. The site drainage was informal with no roof drainage and only limited pavement drainage, whilst the perimeter drain was blocked with stockpiled material in several places. Areas of the site were covered in large puddles and organic sludge through accumulated organic fines that severely limited drainage.

Figure 1 – Example of the organic sludge that used to cover areas of the site

Figure 2 – Ponding water in the perimeter drain prior to the re-development

The site, due to its age, also had no stormwater discharge consent. In order to enable the site reconfiguration a stormwater discharge consent was therefore needed.

Site investigations revealed high levels of heavy metals associated with timber treatment in areas of the site, including Arsenic, Copper and Boron. It was also evident that these metals were present in high concentrations along the perimeter drain, though the concentrations reduced with distance downstream. Despite the high levels of contaminants observed in the perimeter drain, on-site soils and groundwater, at the point of mixing with a small adjacent drain all but one contaminant was within Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) 95% protection thresholds. By the time the flow from site met the main river, the water quality was excellent. This is due to the high level of dilution with clean and rapid moving water that was occurring. However, stormwater treatment was still required by the regional council despite a lack of evidence of any downstream environmental effect from the existing sites historic operation.

At the time of writing this paper the stormwater system had been completed and most site works were completed. Unfortunately, water quality results were not available for the systems finished form due to a lack of meaningful rainfall. Results are presented instead for its interim construction form only, which is essentially a large pond.

2 SITE IMPROVEMENTS

Improvements to stormwater were achieved through a multi-faceted management approach, many of which were required to accommodate the motorway through reconfiguring the site. This included:

- Replacement of several existing buildings with modern weather tight structures with concrete slab foundations. This helped to contain contaminants within the designated areas.
- Improved site practices due to site monitoring (Opus staff, regional council enforcement officers).
- Collection of roof water for direct discharge to the nearby river (reduced overland flow over contaminated surfaces and into perimeter drains).
- Bunding of fuel storage areas.
- Re-grading of the site to improve overland flow to the perimeter drain and minimize ponding water
- Re-grading the perimeter drain to eliminate standing water
- Clearing the drain of stockpiled material that sat within it (sawdust, timber, etc…)
- Removal of the most contaminated soil and replacement with imported clean fill. *Still to be completed at the time of writing.*
- Separation of the stormwater discharge from the adjacent drain via a new outlet channel to the nearby river.
- Provision of sub-surface drainage to control groundwater levels and to direct the flows to the stormwater system
- Provision of a stormwater treatment train for intercepted groundwater and surface water.

The finished stormwater system consists of the following:

- Sediment forebay with submerged outlet pipe for coarse settlement and capture of floating oils, scums and debris (wood chip / bark).
- Oversized low head sand filter.

- Stormwater surface / sub-surface treatment wetland.
- New outlet channel to the nearby river.

Whilst the site was redeveloped and the treatment system constructed, the sawmill site continued to operate at all times and works were phased to fit in around the sawmill operation.

During the sampling undertaken the wetland and sand filter were not completely, instead forming a large combined pond area with a gabion filter wall separating them.

3 SAND FILTER DESIGN APPROACH

The sand filter has been designed to capture and hold all run-off from a 25mm depth rainfall event over any rainfall duration with no allowance for infiltration losses. The 25mm capture relates to approximately 97% of annual rainfall events for the area and was adopted due to the high risk nature of the site. This results in a conservative size, but also reduces maintenance frequency; as long as the water can drain half-way within 24 hours it is considered to be performing. This means the system will still operate with an infiltration rate of 5mm/hour, or even slightly lower. This also allows for the limited head available for drainage.

The sand filter layer (a mixture of sand and compost specified by the regional council) is 200mm thick and sits just above groundwater. Flow through the sand filter displaces the water stored in a porous aggregate below which flows laterally to a central perforated collector pipe which discharges to the downstream wetland.

By not allowing for any infiltration losses in the sizing, sufficient storage is provided in the sand filter to indefinitely hold the entire event such that no by-passing will occur if the permeability is low due to blinding or the wetland level is elevated. This mitigates the low head available, as the water volume can be held back until such a time that there is head available. The sides of the sand filter were lined with filter cloth over free draining rock material to provide additional infiltration once it starts to fill above the sand layer. This acts as a back-up filter if the sand is clogged and not performing.

Figure 3 – Sand filter (lined with a sand compost mix), gabion weir wall and wetland forebay pool (post its first rainfall event)

4 WETLAND DESIGN APPROACH

The wetland has been designed to work in two different ways. Firstly on a displacement principle, where a volume in excess of the 25mm water quality volume is held in surface water and sub-surface water storage within a gravel lining. As the dead storage volume exceeds the water quality volume, the detention time is significantly extended.

Further to this, when displaced flow leaves the wetland it is attenuated to increase residence time and also to limit the rate of discharge. This increases the level of dilution downstream (there are no quantity controls for the nearby river as it does not flood and sits within the functional and undeveloped flood plain of a major river). The sub-surface storage consists of a 500mm deep layer of gravel, which provides a large contact area to improve removal of dissolved metals.

If a valve is opened at the outlet, then the wetland water surface can be drawn down to create sub-surface flow. This options allow for plant establishment and maintenance but may also offer improved treatment via sub-surface flow through the gravel media. The effectiveness of the sub-surface flow regime will be compared to the more conventional surface flow and displacement wetland approach and the better system adopted for the long term operation of the wetland.

Figure 4 – The wetland in its temporary construction form with decanting outlet (this was the sampling point)

Figure 5 – The new outlet channel constructed to separate the discharge from the existing drain

Figure 6 – Outlet headwall with baffle plate, screen and V-notch weir (obscured) under construction

Figure 7 – Placement of the 500mm deep gravel lining underway

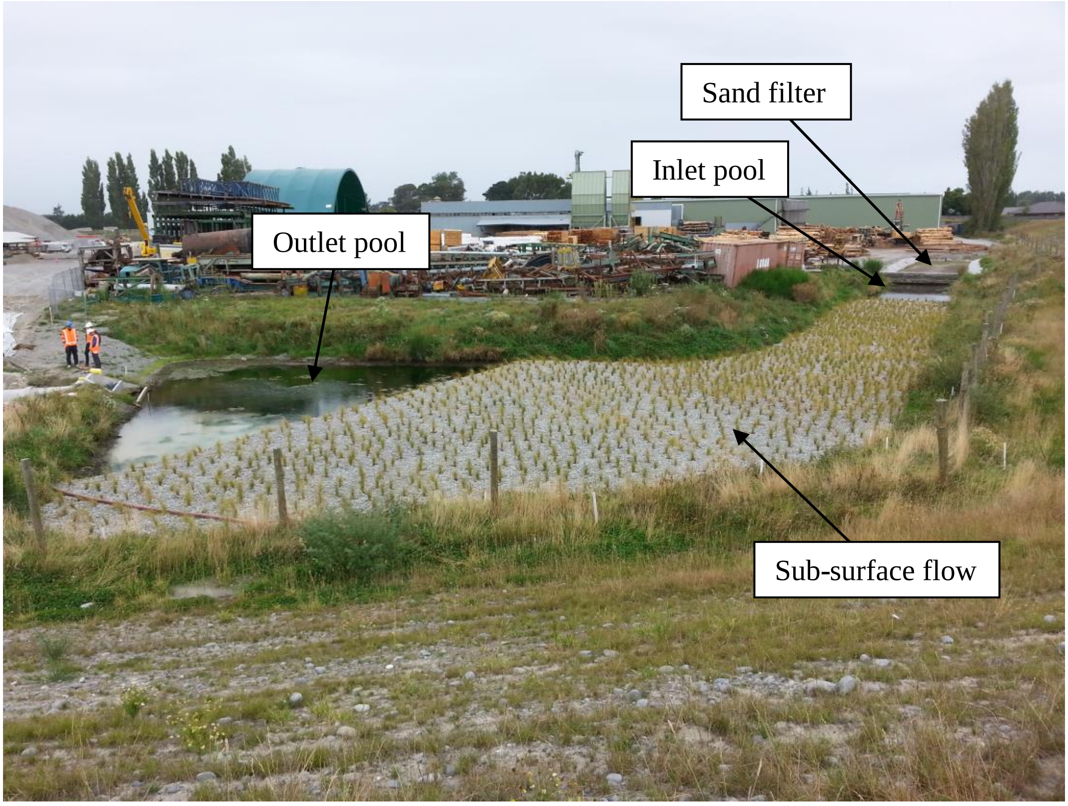

Figure 8 – Finished system viewed from above with a temporarily lowered water level (note the sediment plume in the outlet pool is from an adjacent contractor dewatering into the wetland)

5 MONITORING RESULTS

Monitoring of the wetland to date has been undertaken during its temporary construction form. During this period the wetland was not lined with the gravel layer (increasing dead storage). There was also no sand filter upstream; instead this area acted as a sediment forebay with a gabion filter wall. The temporary outlet consisted of a decanting outlet. Together they formed a large temporary treatment pond.

Unfortunately at the time of writing this paper, there had been insufficient rainfall events to sample the finished system and post-redevelopment influent quality. Sampling of influent quality during the construction works was not undertaken.

The following thresholds were adopted for monitoring quality of the stormwater discharge from the site.

Table 1 – Adopted thresholds

Trigger	Adopted Threshold (mg/L)	Source
TSS	0.025	Visual Clarity (CCC WWDG)
Arsenic	0.013	ANZECC 95% species protection for Arsenic V
Total	0.0033	ANZECC 95% species protection

Trigger	Adopted Threshold (mg/L)	Source
Chromium		
Total Copper	0.0014	ANZECC 95% species protection
Total Boron	0.37	ANZECC 95% species protection
Total Lead	0.0034	ANZECC 95% species protection

Results of the pre and post (temporary construction form) water quality monitoring are presented below in Table 2 along with the adopted threshold and estimated reduction in contaminant. Concentrations highlighted in red are higher than the adopted threshold.

Table 2 – Sampling results (total vs dissolved)

Trigger	Adopted Threshold (mg/L)	Pre - Dissolved (mg/L)	Post - Total (mg/L)	Reduction
TSS	0.025	N/A	0.0175	*N/A*
Arsenic	0.013	0.031	0.0031	90%
Chromium	0.0033	0.0082	0.00135	84%
Copper	0.0014	0.0087	0.00515	41%
Boron	0.37	2.3	0.12	95%
Lead	0.0034	0.00073	0.000235	68%
pH	N/A	6.9	7.8	N/A

Note the comparison above is comparing pre-redevelopment *dissolved* fractions with post-redevelopment *total* fractions and may understate the contaminant reduction achieved as a result. Also note that the average of the post-redevelopment sampling is compared with the lowest value taken from the perimeter drain pre-development. The analysis and reporting of post-development total fractions instead of dissolved fractions was undertaken to satisfy stormwater water consent condition compliance. However, another sampling round will be undertaken during the next rainfall event, during which samples for both total and dissolved fractions will be analyzed.

TSS was not sampled prior to the sites redevelopment, but anecdotally it would have been reasonably high due to the high levels of turbidity observed and the visual plume it generated in the drain. By comparison, the discharge is now visually very clear and contains very low levels of TSS which are comparable to that in the receiving environment.

As can been seen in the results, all target contaminants have been reduced considerably, with only copper still exceeding the stringent threshold adopted (though still reduced by 41%).

Additional to the above results, one set of sampling was undertaken which included dissolved metal fractions. The results of which are presented below in Table 3 with an indication of the reduction from the site prior to the re-development.

Table 3 - Sampling results (dissolved vs dissolved)

Trigger	Adopted Threshold (mg/L)	Pre - Dissolved (mg/L)	Post - Dissolved (mg/L)	Reduction
TSS	0.025	N/A	0.023	*N/A*
Arsenic	0.013	0.031	0.0018	94%
Chromium	0.0033	0.0082	<0.0005	>94%
Copper	0.0014	0.0087	<0.0005	>94%
Boron	0.37	2.3	0.03	99%
Lead	0.0034	0.00073	0.00015	79%

Though this is based on only one event sample, the reduction in dissolved metals is significant compared to the baseline values. Particularly low was dissolved Chromium and Copper, being below detection limits in the sampled discharge.

6 CONCLUSION

Whilst all the planned monitoring and testing of the wetlands operation has not yet been completed, even in its temporary construction form (essentially a shallow pond), a meaningful improvement in discharge has been achieved. How much is achieved through the treatment system itself is not clear at this point as influent sampling has not yet been undertaken (delayed by a lack of meaningful rainfall). However, it is clear that a holistic approach to stormwater management from source control to end of system treatment can achieve a successful outcome for a high risk site. It is the author's intention to provide a follow-on paper once all of the planned testing has been completed.

In hindsight, the key learning from this project was the need for the geotechnical / contaminated land specialists to engage with the stormwater designer early on to co-ordinate testing. Had the initial sampling included total fractions, TSS and phosphorous / nitrogen, a more meaningful comparison could have been undertaken with the consented sampling regime.