TREATMENT OF CONTAMINATED STORMWATER FROM SCRAP METAL YARDS

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ABSTRACT

The accepted industry treatment method for heavy metals management from contaminated site stormwater requires sand/peat media within sandfilter devices. There is no industry standard for scrap metal yards.

For a number of scrap metal yards and car wrecking yards, Hynds Environmental has designed and installed a treatment train that again calls for the sandfilter, but as the final treatment stage. Preceding stages require both point source and end-of-pipe control. Point source in this regard is the capture and removal of oil-based (hydrocarbon) based materials at the vehicle dismantling stage. End-of-pipe relates to treatment of sheet or confluent site stormwater.

The Hynds Smart Sponge is proposed for elimination of hydrocarbons at **source** from contaminated site stormwater. This device can either be installed within cesspits (6L/s), or fitted within existing underground chambers and treating flows up to 12L/s.

The Hynds Downstream Defender is proposed as the first **end-of-pipe** stage to capture gross pollutants, retain suspended solids, and store oily matter.
The subsequent stage is a Smart Sponge vault that captures medium suspended solids and eliminates hydrocarbon products from conveyed flows up to 12L/s.
Finally, the sandfilter utilises the preceding devices as sedimentation stages and provides heavy metals management by sand/peat filtration processes. Treated stormwater is then reused at the facility.

KEYWORDS

Contaminated stormwater, stormwater treatment, industrial wastes, scrap metal, ferrous metals recovery

PRESENTER PROFILE

Rod Murray is the Technical Services Manager for Hynds Environmental involved with the design and installation of innovative stormwater and tradewaste treatment solutions. Rod has experience with scrap metal yard management and the range of associated environmental impacts. He has a Master of Engineering degree and more than 27-years of civil and environmental engineering experience from NZ, the US, UK, Middle East, and the Pacific Islands.

1 INTRODUCTION

The upgrade of an historic scrap handling/recycling/recovery operation at the Mersey Street scrap metal yard in Invercargill was seen by all as a good idea (and about time), yet it had to be done “right” using appropriate technologies that rendered stormwater discharges from the site as safe for the environment, and reusable too.

Treating stormwater from a largely unsealed operational platform with a wide range of recovered ferrous materials was always going to be problematic. No single treatment device was going to provide compliant quality of discharge required for (1) reuse, and (2) discharge to the public stormwater network.

A stormwater treatment train was required that dealt with collection of contaminated stormwater, suspended solids reduction/removal, oily waste mitigation, heavy metals reduction, and storage of product water.

There is no local hazardous waste facility established within the region, so all excavated materials for the treatment train and other site works would have to be integrated into the finished riding/operational surfaces and stockpile pads on the premises. Given the small size of the scrap metal yard (some 4300m^2), there wasn’t much space to work with. The treatment train would only be partially buried meaning that much of the treatment vessels themselves would be above ground.

2 THE BEGINNINGS

The Sims Pacific Metals (Sims) scrap metal yard in Invercargill had been operating for more than 40-years on, reportedly, an historic landfill (uncontrolled dump) site. They recover ferrous metals for use in rebar and wire manufacture, or for export to other nations for reuse.

This area of Invercargill was reclaimed from the New River Estuary in a program of reclamation extending from the late 1940’s until the early 1960’s and was intended to provide Invercargill with additional industrial land.

Over this time the site was mostly unsealed and stormwater that fell on the scrap metal yard was shared with adjacent properties and vice versa. The scrap metal yard is in an industrial area and bordered by a railyard and other storage yards.

Though fenced, there was no effective method to control the transfer of stormwater runoff at the boundary and potential contaminants from non-scrap metal yard related activities might well have co-mingled with on-site wastes.

In his address to local regulators Mr W Watt claims: “this site came to the attention of both Environment Southland and the Invercargill City Council because of:

- Stormwater with a high sediment load and potentially containing hydrocarbons and trace elements leaving the site, flowing onto Mersey Street and potentially flowing onto neighbouring properties
- The possibility that surface and subsurface water flows are being contaminated by stormwater originating on the site and this could be affecting the water quality of the nearby coastal marine area.”

Figure 1: Aerial of Existing Site

Sims' response included a full site assessment completed in September 2008; with further work undertaken completed by November 2010 to investigate the potential for contaminants in soils on the site to impact groundwater and surface water. The subsequent commitment by Sims in the development of the scrap metal yard was the commissioning of Hynds Environmental to provide the stormwater treatment design solution, and participate in its installation and commissioning.

2.1 PURPOSE OF THIS REPORT

This report describes the comprehensive stormwater treatment solution designed by Hynds Environmental Systems Ltd, which was approved by Environment Southland and the Invercargill City Council, and installed in early 2011 to serve the site, and how this addressed the environmental issues identified by the site assessment.

There is no industry standard stormwater treatment system for sites such as the Sims Pacific Metals Ltd scrap metal yard in Invercargill. One needed to be developed that could be provide the versatility for proposed and future scrap metal yard improvements.

These concepts within this report can be used to develop a framework for treating industrial wastes from historical contaminated sites in a way that converts a waste product into a valuable resource for reuse onsite, and perhaps for adjacent businesses in the future.

3 THE DESIGN

3.1 FIRST STEPS

The notion of installing subsurface stormwater drains on a very "soft" site with heterogeneous subsurface materials was discounted early on in the design process. The intention to concrete a portion of the site would make the task of transferring stormwater runoff from the outer reaches of the site overland to a central point relatively straight-forward, however more than two-thirds of the site would remain unsealed and prone to undulation from variable dead loading conditions. The usual method of stockpile removal meant that large divots would remain and cause ponding.

The proposed site layout meant that a small area of land adjacent to a relocated building would be largely under-utilised and could be an ideal location to site a stormwater treatment system. The question was the size of the proposed treatment plant and could it all fit in?

Initially the site was to be regraded to help with conveyance falls, and have a small cut-off drain and/or low-height wall installed at the perimeter of the property.

Also proposed was a concrete car-dismantling pad allocated at the south-western corner of the site. This is typically where the majority of the hydrocarbons experienced on the site are expected to be released. This pad was proposed to have its own Smart Sponge treatment system integrated into a pump station. This stage of the development works may be addressed in future improvement works.

3.2 TREATMENT DESIGN ELEMENTS

Hynds addressed each of the wastes presented with a dedicated piece of treatment equipment as follows:

1. Gross pollutants, coarse suspended solids, and small measures of oily waste: Downstream Defender [Element 1]
2. Heavy hydrocarbon loading: Smart Sponge [Element 2]
3. Heavy Metals: Sandfilter (filtration by sand/peat media) [Element 3]

There was also a requirement to retain treated stormwater for site applications such as dust mitigation and truck wheel washing. A water storage vessel [Element 4] was added to the treatment train design and is to receive water directly from the sand filter (filtration chamber).

These types of treatment components are normally completely buried so the method for reusing stored water would require a small pump chamber [Element 5] to send treated waters to:

- An optional dust suppression ring main
- Proposed on demand truck wash
- Public stormwater reticulation (for disposal of unused or surplus stormwater)

This pump station would also have a Rainbank system installed such that mains make-up water could be utilised at the pump station until the water storage tank had been replenished. An important design consideration was that the treatment system could be isolated and taken completely off-line for maintenance without impacting site operations. The pump station would provide a range of system versatility.

The design was reliant on a central collection vessel (manhole) that could take additional pipework as future development works permitted. This manhole would also have a grate atop the precast concrete lid and act as an integrated cesspit/manhole (IMH-A) [Element A] so saving on buried infrastructure and ensure that the large flanged based manhole would suitably handle the soft ground and variable water table conditions. IMH-A was designed to precede the Downstream Defender and accommodate the S-Bend structure that serves to restrict floatable material from entering the device and aid in hydraulic performance. IMH-A would be installed within the proposed concrete apron about the buildings and in a heavy traffic load area.

This treatment train was presented to the relevant regulatory authorities and proposed as the solution to address each of the environmental issues that affected the site.

The design was accepted and works proceeded to engineer the site improvements works on the basis that a working stormwater treatment solution existed.

3.3 DESIGN MODIFICATION

Soon after the site development design works matured, the question of disposing of contaminated excavation material was raised and this presented a host of issues. There was no suitable waste disposal facility locally available to accept the range of solid and aggregate wastes.

The civil engineering choices for developing the site had a serious constraint and it soon became apparent that the largest volume of excavated material would be from the stormwater treatment train installation works.

The option to install the treatment train completely above ground was debated and discounted as there would be a range of stability issues and associated expense in forming suitable plinths to support the various tanks that each differed in diameter/width and height, and accordingly mass. Though having the system above ground could eliminate the downstream pump station, there would be some loss of system versatility.

An above ground treatment system would need a preceding pump station to enable gravity flow from the first treatment stage.

As a compromise, the system was to be vertically configured such that the shortest treatment component sat directly atop the proposed concrete apron and each of the preceding and subsequent treatment devices would be partially buried. This meant that the cast iron manhole frames and covers of each device would be at the same height above the pad and the depth of excavation for each would be a function of unit height (or depth).

The downstream pump chamber would still need to be completely buried to accommodate the sandfilter discharge invert level, though the pump vessel could be reduced in height and thus reduce the associated excavation volume.

Upstream, a bit of additional work was required to modify IMH-A to take a pump, and the required reduction in excavation depth resulted in a slightly larger diameter chamber. This actually worked better for the pumping solution as the volume and variability of sediment expected in this chamber would be well catered for.

The Downstream Defender as mentioned is a vortexing type of device and requires gravity flow to initiate its separation process. A balance chamber [Element B] would be required to accept pumped flows and enable sufficient head through the 225mm diameter discharge pipe prior to primary treatment.

3.3.1 INSTALLATION IMPROVEMENTS

Each treatment device and associated chamber was configured such that it would fit within the available footprint adjacent the site building. Any changes to the treatment or pumping philosophy would require piping variations as tanks simply wouldn't fit in any other configuration.

During installation, the contractor made design refinements based on where the stormwater pipework was actually laid and the decision to configure the discharge from the sandfilter directly to the downstream pump station was made. Instead of diverting the pipe around the water tank it was taken straight through and sealed at entry/exit. The pump station would no longer pump out for reuse/disposal, instead serving only to fill the water tank.

A pump was installed inside the water tank and this pumps out for reuse and disposal as required. Overflow from the water tank can be via gravity (function of hydraulics) or pumping solution (inside the water tank) to the public stormwater reticulation network.

Figure 3.3-1 shows the final elevation of the treatment train and associated conveyance components.

The following is the list of units (1-7) that were installed January 2011:

1. Element A: IMH-A – Upstream pump station (fully buried)
2. Element B: Gravity balance tank (above ground)
3. Element 1: Downstream Defender (partially buried)
4. Element 2: Smart Sponge Vault (above ground)
5. Element 3: Sandfilter – filtration chamber (partially buried)
6. Element 4: 23660L water storage tank (partially buried)
7. Element 5: Downstream pump station (fully buried)

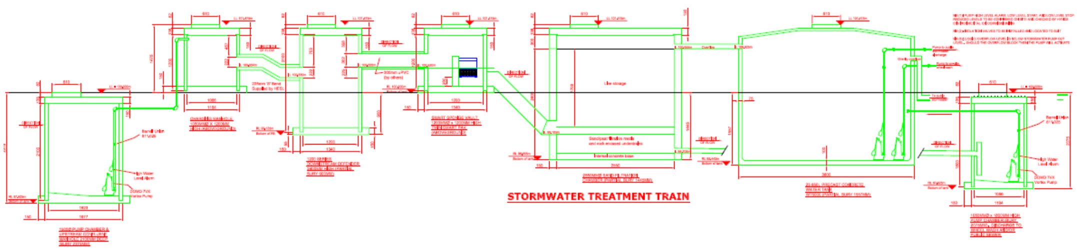

Figure 3: Elevation of Treatment Train

There is a silver lining to this buried and above ground design and this relates to maintenance, and health and safety. Given that the top of all precast concrete units are effectively at the same height above the concrete slab, personnel servicing the treatment units can safely navigate between them. Each element was tightly installed in the configuration as shown in Figure 3.3-2 and this lends itself to providing wooden bridging for access to all manways.

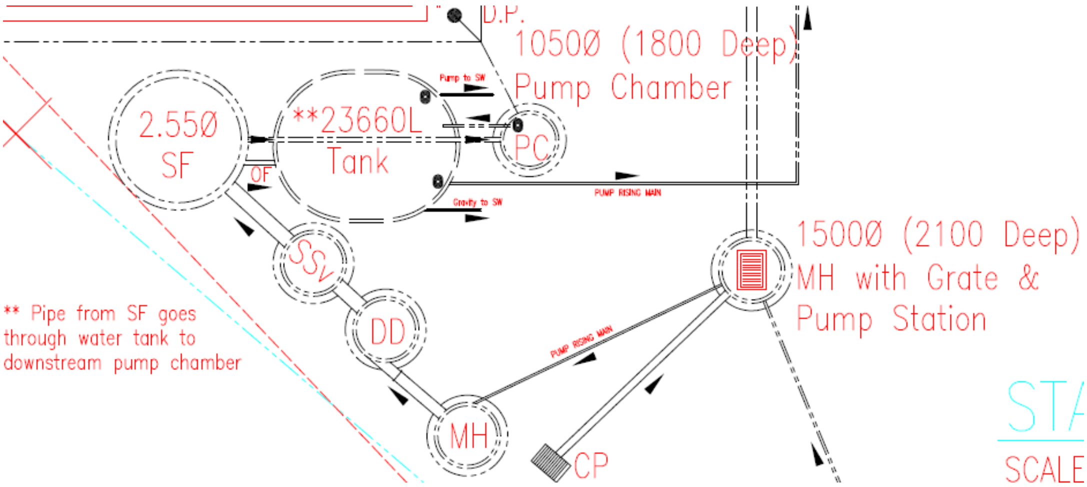

Figure 4: Plan of Treatment Train

CONSTRUCTION IMAGES

As seen from Figure 5 the site was very flat, with the proposed location for the treatment train close to the perimeter boundary.

Figure 5: Cleared site

Figure 6: Upstream pump chamber (IMH-A)

Figure 7: All units partially buried (looking at the water storage tank)

Figure 8: Installation complete

Figure 8: Laying the concrete skirt about the treatment train

Figure 9: The treatment train laid out from left (Unit 2, 3, 4, & 6 visible)

Figure 9: Treatment train in place, plumbed in, and concrete apron completed

3.4 DETAILED TREATMENT TRAIN COMPONENT DESIGN

3.4.1 DOWNSTREAM DEFENDER

The precast concrete Downstream Defender (DD1200) selected has a design flow of 20L/s and capacity of 85L/s. This was based on the local rainfall intensity figures provided by GM Design and the site catchment splits between impervious and pervious contributing surfaces. The treatment train elements were then sized in series to cater for 20L/s.

The Downstream Defender is designed to remove settleable solids, floatables, oils and grease from stormwater runoff. Full-scale test results show settleable solids removal efficiencies of 90% at design flows. Because the sediment and oil storage areas are outside the main flow path through the unit, previously collected solids, oil and floatables are not re-entrained in the effluent during major storm events or surcharge conditions. In addition, treatment capacities are not reduced as pollutants accumulate between clean-outs.

3.4.2 SMART SPONGE VAULT

The precast concrete Smart Sponge vault (SSv) was sized for two modified Ultra Urban filters in parallel with a combined flowrate of 12L/s. These units were attached to a weir wall inside a 1200mm dia. manhole. The weir formed two distinct chambers, the first being to accept treated water from the DD1200 and "calm" these so that oily matter floating atop the water surface would evenly flow over and into the secondary chamber where each Smart Sponge unit would retain 90% of all incoming oily liquid within the polyester product.

The first chamber would also act as a buffer under high rainfall conditions. Under these conditions high flows would also overtop the weir and bypass the Smart Sponge devices and be conveyed directly to the sandfilter.

Field and laboratory tests have confirmed the capability of the Smart Sponge to absorb, depending on the type of oil contaminant, up to three times its own weight. The product will remove up to 95% of hydrocarbons present in stormwater runoff, typically in the range of 5 to 30 mg/litre (ppm). The captured oil is permanently bound within the Smart Sponge, eliminating leaching and allowing for easy disposal of the filtration media.

3.4.3 SANDFILTER

The final treatment stage required locally sourced sand/peat media within a precast concrete filtration chamber. Normally a sandfilter requires sedimentation and filtration components, however given the upstream treatment units (DD1200 & SSv) the filtration chamber design was adjusted to cater for the treatment and live storage potential. The overflow from the sandfilter was directed into the adjacent water storage tank.

Hynds Sand Filter Systems are designed to treat stormwater runoff with the following performance criteria:

- Retention of ≥ 75% of total suspended sediments
- Capture of floatables, oils & grease
- Ability to store increased flows during storm intervals
- Bypass device to prevent unit flooding at peak flows

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4 CONCLUSIONS

- Scrap metal yards are a legitimate and necessary activity in a rural servicing city like Invercargill. The character of the area is industrial and the District Plan provides for scrap metal yards as a Permitted Activity. Though investigations have shown that the site is contaminated, the Activity is an appropriate use of the site.

- Ministry for the Environment considers scrap metal yards as likely to cause land contamination resulting from hazardous substance use, storage or disposal.

- For this site the best way to avoid, remedy, or mitigate the effects of contamination is to contain it onsite.

- The works once completed will (1) enable stormwater to be collected and treated prior to reuse or discharge to the city's stormwater reticulation system; and (2) mitigate the effects of any windblown transmission of contaminants with a stormwater reuse regime involving truck wheel washing and on-site sprinklers.

- Stormwater treatment trains design provides the best water quality improvement solution but needs careful consideration to civil engineering constraints, ground conditions, waste disposal, and constructability issues.

- Stormwater treatment design can be iterative on the basis of information discovered.

- The robust design and ability of each Hynds Environmental component to treat was vital to the success of the project, though refinements were made to the final orientation design to accommodate as-built conditions.

- No single stormwater treatment device could suitably cater for the variable wastes encountered on this industrial site and meet the requirements to address each key environmental issue.

- This type of treatment train required a consultative process to regulators to ensure by in from key stakeholder by in, and that the accepted design solution was practical and economical.

- The site was developed using the least volume of excavated material being redistributed about the site.

ACKNOWLEDGEMENTS

William J Watt BA DipTP MNZPI FNZIM, William J Watt Consulting Ltd

Erne Joyce FAMINZ (Arb. Med. Adj),MS Const. Law, MNZPI, MNZIBS, MAANZ, Life Member BOINZ & MNZICW, AAA Design & Consultancy Ltd

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