

# INNOVATIVE TREATMENT SOLUTIONS FOR CHALLENGING SITES

Mike Hannah  
michaelh@stormwater360.co.nz

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## KEYWORDS

Stormwater treatment, Retrofit, Soakage, Low head

## • INTRODUCTION

Stormwater designers are often faced with challenging sites for stormwater treatment; the most common difficulties are a lack of fall or a lack of space.

This paper details three different case studies where the site conditions were prohibitive to installing traditional treatment methods. Innovative solutions were developed by adapting stormwater technology to fit within existing stormwater infrastructure, to overcome the site constraints

The projects are as follows:

- A low drop filter with surface-level entry, pre-treating a plastic detention system at Penrose high school. The outlet from the treatment device could be no deeper than 500mm from ground level.
- A screening system for gross pollutants for a public soakage network in Epsom, Auckland. A screening device was retrofitted into an existing urban network to protect a soakage disposal system from clogging.
- An integrated filtration/ drywell for an infiltration system on a NZTA arterial upgrade-Pound Road in Christchurch. The treatment system designed integrated a filtration system with a drywell to minimize the number drainage structures required on site.

The paper reviews the design criteria including hydraulics, targeted contaminants and sizing for these three projects. The paper also details the installation of these systems and looks at how they are performing now.

## • PENROSE HIGH SCHOOL – SURFACE ENTRY, FILTER

Often stormwater designers we are faced with a sites that have a lack of fall. All stormwater treatment devices have a hydraulic effect. Weather this be the flow over the outlet weir on a pond, the roughness coefficient of a swale or the driving head for a filter.

Penrose high school was such a site for consulting engineer's Mitchell Vranjes. Auckland City and Auckland Regional Council regulations required a detention tank to control the discharge to the existing pipe system and that runoff be treated to TP10 standards; i.e. 75% suspended solids. Difficulties arose as the connection to the existing reticulation system is only 1.1 m below the car park surface level.

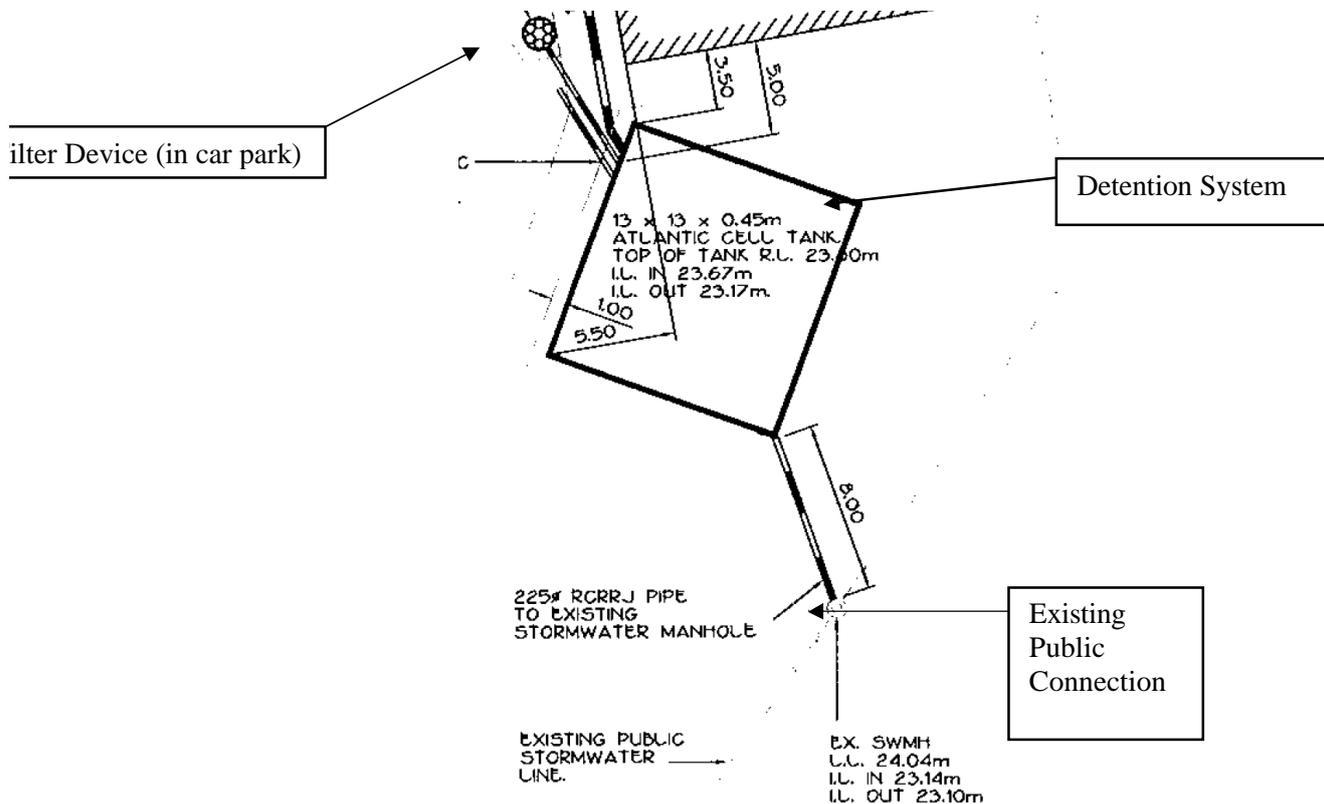


Figure 1: Penrose High School Layout  
Source: Mitchell Vranjes Consulting Engineers Limited

The solution was to use a low drop StormFilter configured to sit in a manhole with a scruffy dome, followed by a modular, plastic "milk crate"-type detention tank. The low-drop StormFilter cartridge requires only 280mm of driving head to prime the siphon. The design comprised of an 1800 diameter manhole with 6 low-drop cartridges. Low-drop cartridges are the same height as the standard cartridges but they have a float that is shorter than the standard float allowing the siphon to be primed at a lower level. The lower priming level the low drop StormFilter cartridges results in a lower than normal operating flow rate of 0.6 L/sec. The filter was designed to treat 80% of the annual runoff from the 2400m<sup>2</sup> of new car park area.

The StormFilter is a passive, flow-through, stormwater filtration system. Stormwater is filtered through media filled radial cartridges deployed in a concrete structure. The cartridge uses a syphonic mechanism to draw the stormwater through the media. The syphonic mechanism in the cartridges enables the StormFilter to have a large filter surface area with a relatively small foot print. The large surface delivers low hydraulic loading rate during the filtration process and allows filtration with low driving heads. The StormFilter is approved by the Auckland Regional Council as a best management practice to achieve 75% removal of suspended solids.

Figures 2 and 3 show the plan and elevation of the surface entry low drop StormFilter. Surface water enters the filter through the scruffy dome as indicated. The water level in the filtration chamber needs to rise to the priming height before flow is initiated through the cartridges.

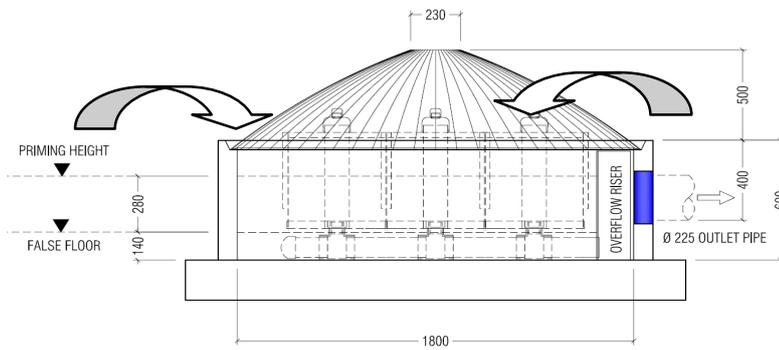


Figure 2: 6 Cartridge Low Drop StormFilter with Surface Entry (Elevation)

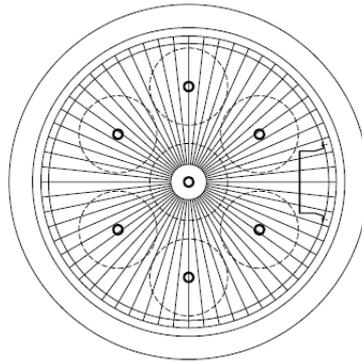


Figure 3: 6 Cartridge Low-Drop StormFilter with Surface Entry (Plan)

After monitoring for the first 12 months the maintenance requirements have been determined. It is recommended the media be changed every 12 months and the debris be cleared around the cartridge every 6 months because of the tree cover in the catchment.



Figure 4: Photos of Catchment, Installation and Inspection

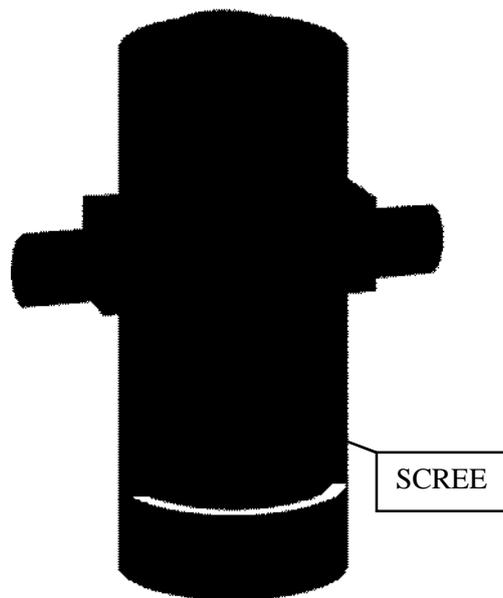
The low-drop StormFilter enables on-site stormwater treatment to be achieved on a site where conventional stormwater treatment would not have been possible. Installing the a filtration device upstream of the detention prevents clogging and failure of the detention system.

- **SELWYN AVE GROSS POLLUTANT TRAP**

Soakage or infiltration is very prone to clogging from sediment and debris. Auckland city has over 2100 soak holes draining public roads in Epsom, Mt Eden Sandringham and Onehunga. Often these soak holes are the only disposal point for the runoff, therefore protection of these assets is important to the City. One method of protecting the soak hole is by installation a gross pollutant trap or GPT up stream of the soak hole. A gross pollutant trap is a stormwater treatment device designed to capture pollutants over 5mm in diameter.

Auckland City commissioned Morphum Environmental to evaluate various GPTs available to protect a new soak hole in an area of Epsom which was prone to repeated flooding. After evaluating all the available devices Morphum chose a VortCapture™.

The VortCapture™ is a stormwater treatment device designed for the removal of trash and organic debris from stormwater runoff. VortCapture is a uniquely designed full capture device. It removes all particles 5 mm and greater from treated flows, including neutrally buoyant material. It also effectively removes settleable solids and free-floating oil and grease.



*Figure 5: Vortcapture™*

The internal components of the treatment device are made of marine grade aluminum and include a perforated screen with 4.8 mm diameter apertures. These components are housed in a pre-cast concrete manhole. Due to its lightweight, compact design VortCapture™ is well suited for tight sites

VortCapture™ employs a screen design that maximizes hydraulic capacity and minimizes blinding. During operation, a tangential inlet causes stormwater to swirl in the circular treatment chamber (see figure 6). Buoyant materials migrate to the center of the treatment chamber and rise above the screen while non-floating pollutants are trapped in the sump below. The vortex action creates high tangential velocities across the face of the screen relative to the normal velocities through the screen. This indirect screening feature scours the screen, preventing the “stapling” of debris into apertures, which can clog screens and restrict flow.

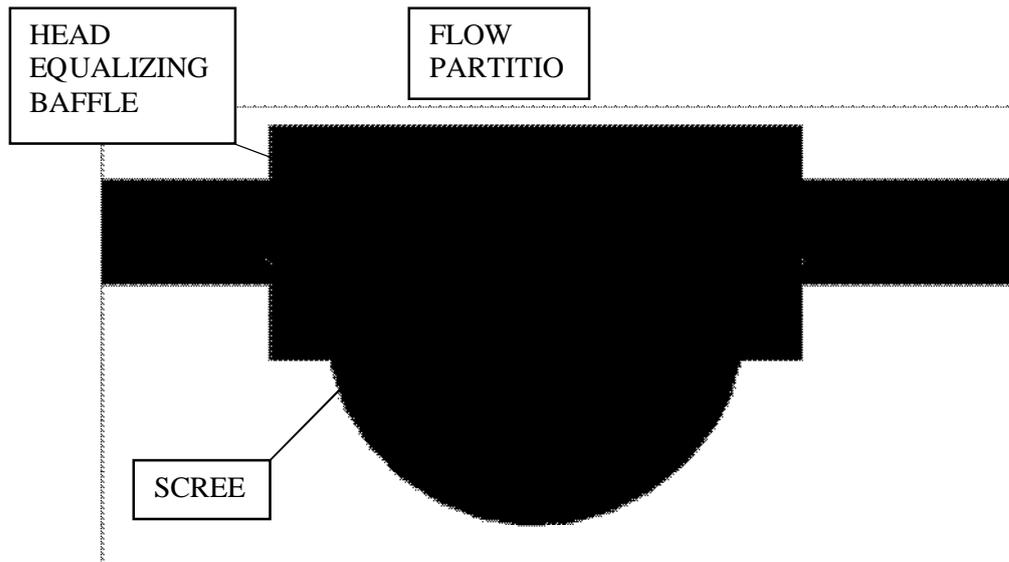


Figure 6: Vortcapture™ Plan shown

VortCapture™ was sized to treat a 1 in 10 years storm, which was approximately 300 L/sec. At these flow rates all runoff is directed into the treatment chamber. At higher flow rates, a portion of the runoff spills over the flow partition and is diverted around the treatment chamber and screen, filling the head equalization chamber. This collapses the head differential between the treatment chamber and the outlet, resulting in a relatively constant flow rate in the treatment chamber even with a substantial increase in total flow through the system. This configuration reduces the potential for pulverization or washout of previously captured debris and sediment.

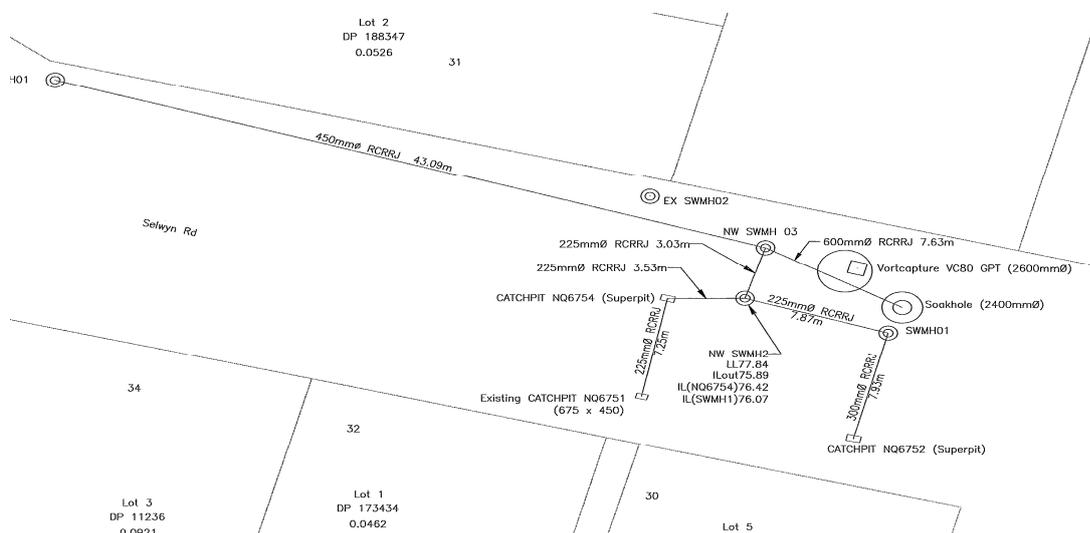


Figure 7: Selwyn Ave Plan View  
Source: Morphum Environmental

Figure 7 shows the limited space available to install the device. Figure 8 shows the stage discharge curve for the VortCapture™ at Selwyn Ave. The blue line shows the flow and corresponding tail water from the water entering the swirl chamber. The yellow line is the total flow through the device including flows that pass over the flow partition. The tail water level should be used in the design of the reticulation system (Figure 8) assuming that this is the water service level of a reservoir.

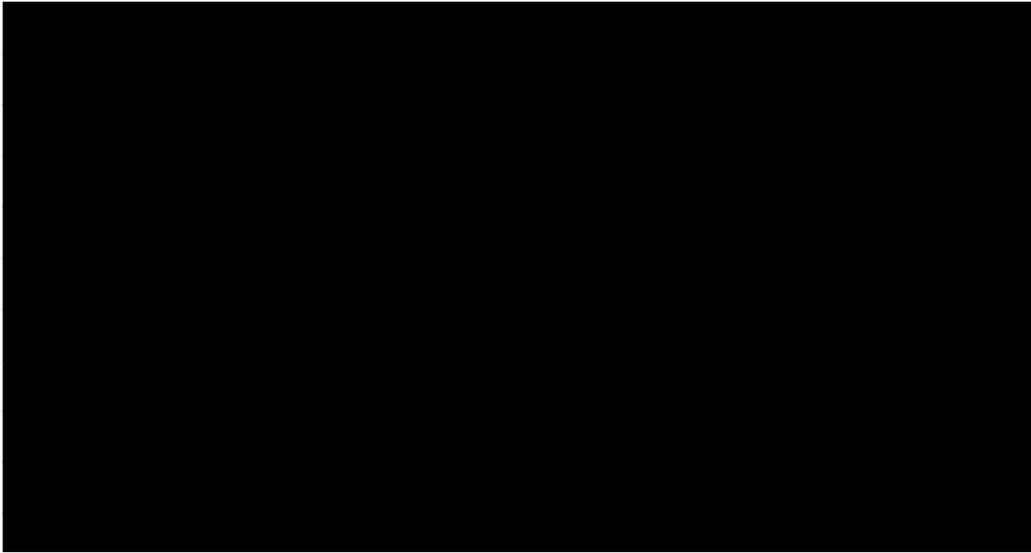


Figure 8: Selwyn Ave Staged Discharge Curve

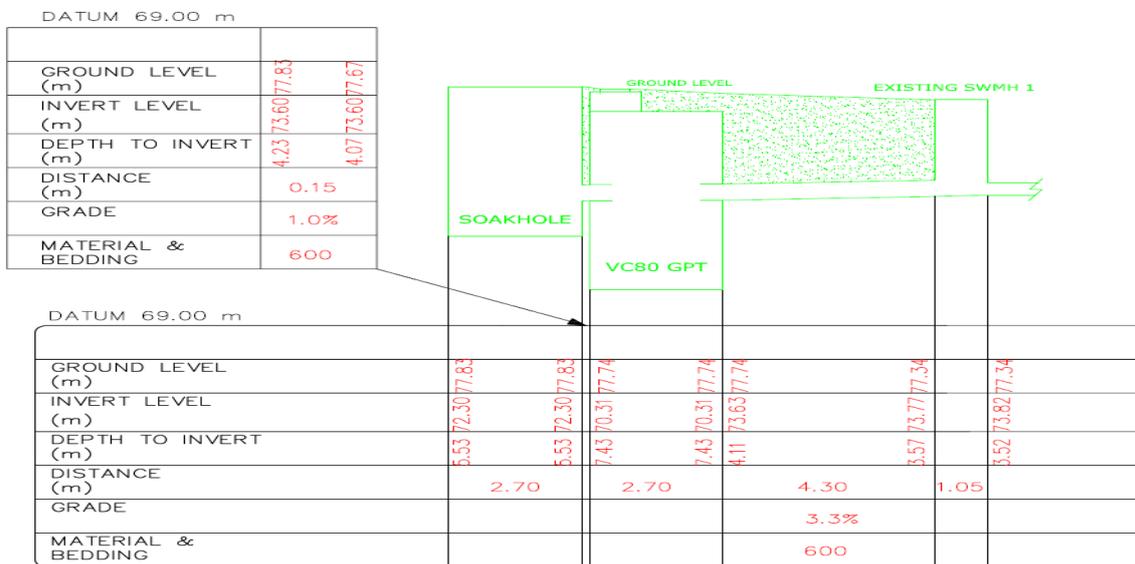


Figure 9: Selwyn Ave Staged Long Section  
Source: Morhum Environmental



Figure 10: Selwyn Ave VortCapture

- **POUND ROAD / CHRISTCHURCH**

Pound Road SH 73 intersection upgrade is a essential NZTA Christchurch motorways initiative. The project involved major modifications to the existing intersection to create a new “round about”. The additional paved area generates additional stormwater runoff with high levels of contaminants, due to the high traffic movements. The proposed stormwater disposal was to be by deep soakage via an infiltration trench. Environment Canterbury requires the treatment of the runoff before discharge to soakage.

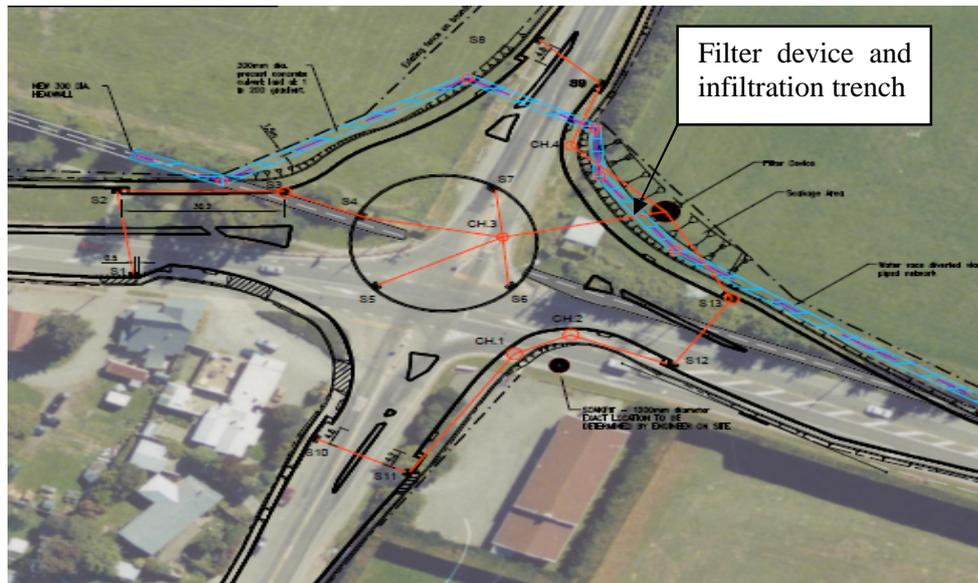


Figure 11: Pound Road Interaction Upgrade  
Source: AECOM

Environmental engineering consultancy AECOM contacted Stormwater360 to discuss the options for treatment. Stormwater 360 came up with the idea of incorporating the filtration system into the soakage structure. Figure 12 shows the standard detail for deep soakage in the “Christchurch City Council Waterway, Wetland and Drainage Guide” (left) and a modified version, incorporating the StormFilter. The modified well included seven StormFilter cartridges, which filter the runoff and discharge directly downwards the storage chamber. The treated water then makes its way through the perforated riser into the gravel infiltration trench which was constructed at depth.

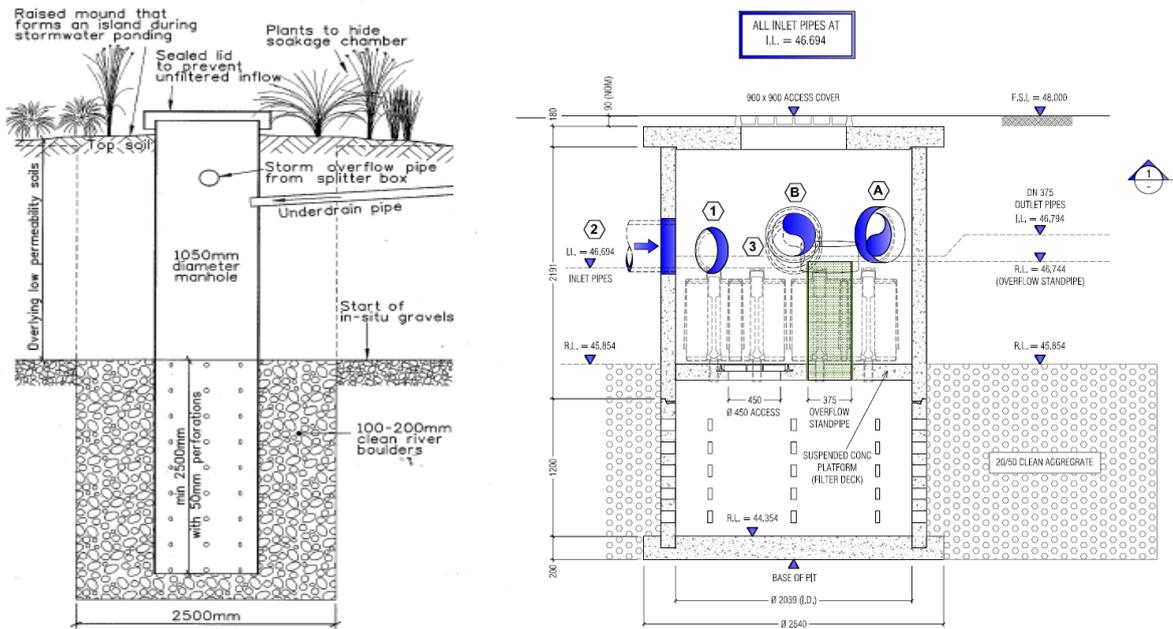


Figure 12: Christchurch City Deep Soakage Standard Detail and Modified Soakage Well StormFilter

Figure 13 shows the system in plan view. Access to the storage chamber can be gained through the standard manhole access lid. Another feature of the design is the overflow standpipe with overflow baffle. This allows flow greater than the treatable flow rate to siphon through the riser, preventing floatable from making their way to the storage chamber. Figure 13 shows the installed unit where a cartridge hood is used as the floatable baffle.

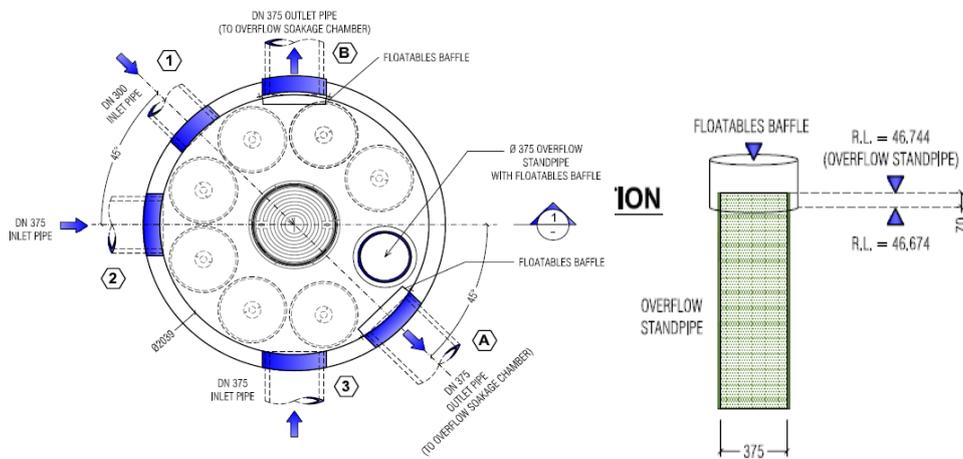


Figure 13: Soakage Well and Overflow with Floatables Baffle

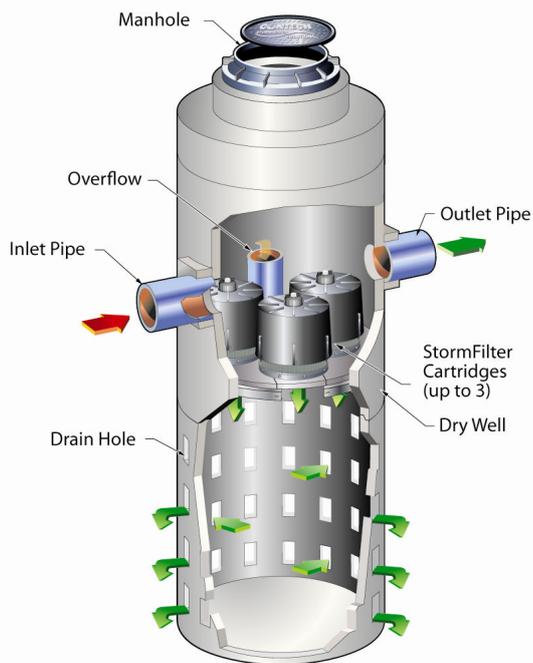


Figure 14: Conceptual perspective of soak well and inside the unit installed at Pound Road

## • SUMMARY

This paper has shown examples of how stormwater treatment can be applied to even the most challenging sites.

New technologies such as the StormFilter and the VortCapture™ allow separation of solids from stormwater in situations that would be prohibitive to conventional forms of treatment, such as when retrofitting into existing urban areas, in the case of geographical site constraints and on “hydraulically tight” sites.

Stormwater treatment has been achieved with these technologies not only to protect the environment but to protect and prolong the longevity of other stormwater assets; i.e. stormwater detention tanks and ground disposal systems.

New innovative technologies offer the flexibility to be incorporated in to conventional drainage structures such as soakage wells. This saves money, time and hydraulic driving head; removing the need for two separate structures.

## • ACKNOWLEDGEMENTS

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