Enviro - Process Testing Summary

By: Leo Crasti, Director
Date: 27 February 2018

Summary

The following summarises the results and conclusions derived from University Research and Independent Testing at both SESL (NATA Certified Laboratories) and Manly Hydraulics Laboratory (MHL) in Sydney.

1. Gross Pollutant removal ………….……100%
   Construction of the Enviro devices includes proprietary screening with apertures of 1mm or less. The entry is one-way, reverse flow is impossible, and the configuration does not allow re-suspension.
2. Sediment removal has been modelled and tested in several ways. The conclusion derived is that the screening system successfully removes the majority of particles that are less than 50% of the aperture size.
3. Sediment removal ……………………..…86%
   Testing utilised a PSD with a bias towards fine sediment where 90% were less than 500 microns and 35% of the particles were less than 53 microns. Removal rate achieved was 81 to 86% across a range of flow rates and concentrations.
4. Nutrient removal, potentially ……………80%
   The fact that sediments are the major transporters of TN and TP is well established. This only varies for discharge from wetlands where release has occurred. Sydney University students researched the release rate of both N and P from catchment materials and concluded that wetted durations of greater than 10 minutes were required to achieve significant release. These studies confirmed that early capture of particles represented a viable method of substantial nutrient export.

MUSIC Nodes are available. These have been developed by UniSA, after peer reviewing field and test data.

Enviro policy is to not self-certify, hence *MUSIC* Nodes are prepared by qualified independent parties.

In addition to internal Enviro device performance, other factors add to performance in operation.

Firstly, all devices are fitted with 600mm wide covers. These are centrally located giving service personnel the ability to see all surfaces and the storage chamber. Entry is not required.

Secondly, the storage chamber is accessed via a central turret enabling an evacuation hose to be lowered and manoeuvred to reach all storage areas.

Thirdly, screens are removable for wash down and/or replacement as required.

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Background

Enviro Aus Pty Ltd (Enviro) is dedicated to the improvement of water quality which has been adversely impacted by anthropogenic activities, with priority to urban runoff.

The technologies developed by Enviro are the subject of Intellectual Property Protection.

Enviro is a registered with AusIndustries as a Research Organisation and has qualified for R&D assistance.

The Director of Enviro (Leo Crasti) has a Bachelor Degree in Mechanical Engineering. His research involvement includes:

1. Sponsored research with Sydney University on process modelling, particle attraction and particle transport of nutrients.
2. Collaboration with Western Sydney University on urban run-off.
3. Developed a full scaling process testing program that was conducted at Manly Hydraulics Laboratory in Sydney.
4. Presented a paper to International Science Conference.
5. Contributing author to *“Balanced Urban Development: Options and Strategies for Liveable Cities”*, published in September 2016.

Enviro Group activities were relocated to South Australia in 2017. Collaboration with UniSA has been established and construction of a permanent testing facility at CPC is in progress, due for completion in April 2018.

Introduction

Under Australian Consumer Laws, any product should be fit for purpose and any performance claims need to be based on recognised codes or some form of testing, which should be supported by known and accepted methodologies.

In the case of Stormwater Quality Improvement Devices (SQID’s), there are no codes or testing standards and terminology used not properly defined.

During development of the processes included within the Enviro GPT and EPS products, the Director adopted an empirical testing method that mimicked rainfall events and replicated the various loads that may potentially be discharged from a catchment.

The empirical method required known material to be injected into a known flow rate in varying concentrations.

Testing was managed by independent parties with a full-scale unit installed at Manly Hydraulics Laboratory. 38 tests were conducted, with flow rates up to 200 litres/sec and over 1 million litres passing through the test unit.

Attached are extracts of testing and the results.

Later, a full compilation was presented to UniSA from which MUSIC Nodes were created, supported by a report on the data, node options and recommendations.

A copy of the UniSA report is also included.

Extracts from MHL Report.
This report was provided to UniSA
in full under a non-disclosure and
confidentiality understanding.

Methodology

The test program consisted of a series of tests using two prepared stormwater mixes (typical and fine sediment) at different concentrations and various flowrates to mimic a range of potential applications. Total material loads, flow rates and water samples at the inlet and outlet of the device were taken to estimate the rate of suspended solids removal.

Results

Testing of the SDU-2 unit showed:

- 84 to 86% average total suspended solids removal across a range of flows up to the nominal treatable flowrate for the typical stormwater sediment mix
- 81% average suspended solids removal across a range of concentrations for a fine sediment stormwater mix at the nominal maximum treatable flow rate
- complete removal of gross pollutants up to the nominal maximum treatable flow rate (by visual observation)
- a measured resistance headloss coefficient, K-value of 0.43 across the unit.

Discussion

Defining laboratory stormwater mixtures for performance testing of any SQID is problematic. No Australian standard protocol is currently available, measured pollutant loads from around Australia vary widely, and target influent concentrations can be difficult to achieve. In particular, the influent particle sizes can have significant effect on the results and is an important factor in assessing the performance results. In this regard, it is noted that the fine sediment stormwater tests carried out at the maximum treatable flow is likely to have biased the results to a lower performance than would be expected from a more typical stormwater mixture.

It is also commonly recognised that gross pollutant associated nutrients and particulate bound phosphorus removal in stormwater occurs with removal of suspended solids.

Full scale laboratory testing is undertaken to assess its hydraulic performance and pollutant removal performance against key water quality parameters in controlled and repeatable conditions.

Currently there is no standard for the testing of stormwater devices recognised in Australia, either in a controlled laboratory or field situation. The testing methodology adopted was developed by Retaw in consultation with Blacktown City Council, MHL, Environmental Consultants Australia (ECA) and Sydney Environmental and Soil Laboratory (SESL). It draws on information from Engineers Australia's *Australian Runoff Quality: A Guide to Water Sensitive Urban Design 2006 (ARQ)*, the 'New Jersey protocol' (NJDEP 2013) and eWater (L. Crasti, *pers. comms)*.

MHL recognises the importance of industry collaboration in aiming to develop SQID testing protocols.[1] One of the difficulties faced in developing a protocol is recognising the full breadth of conditions these units may be subject to in the field, for example, storm intensity and event history, land use type, system maintenance regimes, runoff rates and pollutant loadings. Total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP) are often used as key stormwater pollutant parameters. The ARQ presents average levels of TSS, TN and TP in urban runoff (adapted from O'Loughlin 1992), as well as guideline levels for healthy waterways:

- Suspended solids: 250 mg/L in urban runoff (variance of 13-1,620mg/L), guideline of <25mg/L.
- TN: 3.5 mg/L in urban runoff (variance of 0.5-13mg/L), guideline of <0.5mg/L
- TP: 0.6 mg/L in urban runoff (variance of 0.1-3mg/L), guideline of <0.05mg/L.

The testing presented in this report focusses on suspended solids removal, however it is commonly recognised that gross pollutant associated nutrients and particulate bound phosphorus removal occurs with removal of suspended solids.

2.1 Test Bench

A test bench was designed for each test unit to enable a constant flow of near-homogeneous synthetic stormwater to the unit throughout the test, and allowing grab samples to be taken at influent and effluent points.

Each test bench consisted of:

- the unit under test
- base water supply
- a flow meter
- a hopper for mixing of the pollutant load into a homogenous solution before injecting into the base flow
- a progressive cavity pump for controlled dosing of the pollutant slurry into the base flow
- tappings at the inlet and outlet for sampling and head loss testing
- associated pipework for inlet and outlet conditions.

The removal of sediment was a priority focus of the testing program.

Sediments were collected by independent consultants. These sediments were anticipated to be biased towards finer materials as they were collected from the discharge of existing wetlands. If these materials were substantially removed by the test device, then the tested processes could be deemed to be more effective than the sediment basin.

This fine sediment was labelled as Mix A. The psd for Mix A was then compared to the ARQ proposed typical urban discharge sediment PSD. (refer Fig 4)

Mix A showed 95% was less than 500 microns in comparison to the ARQ typical of 65%. Furthermore Mix A recorded 35% was less than 53 microns, whilst the ARQ typical was only 10%.

A Mix B was created by blending coarser soil materials with the Mix A to create a typical sediment.

Both sediments were testing at varying concentrations and flow rates.

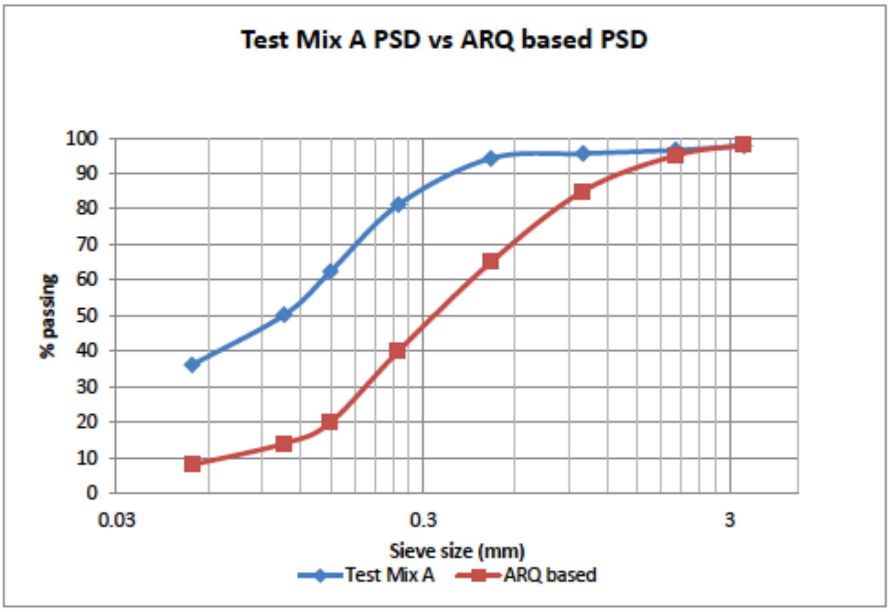


Figure 4: Test Mix A - Particle Size Distribution

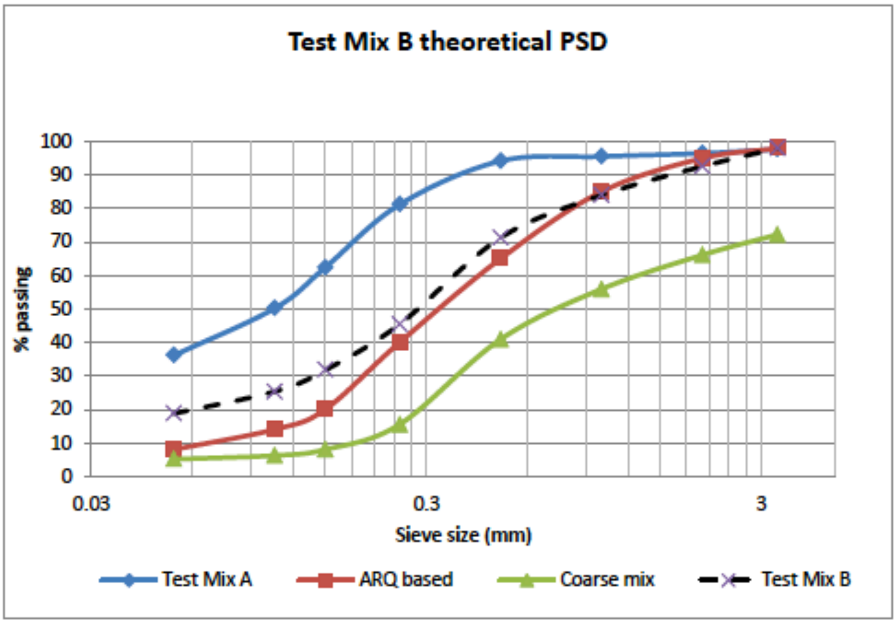


Figure 5: Test Mix B – Theoretical Particle Size Distribution

The sediment test results are shown below.

Mix A removal rated across varying concentrations from 40 to 2800 mg/l and varying flow rates from 20 to 100 L/sec showed average removal rates of 81 and 86% respectively.

Mix B tests (not shown) showed removal rates of 84 to 86% in similar tests.

Testing Conclusion is that the sediment removal process in the Enviro Device is a reliable method for the removal of a majority of sediments anticipated to be transported from urban run-off.

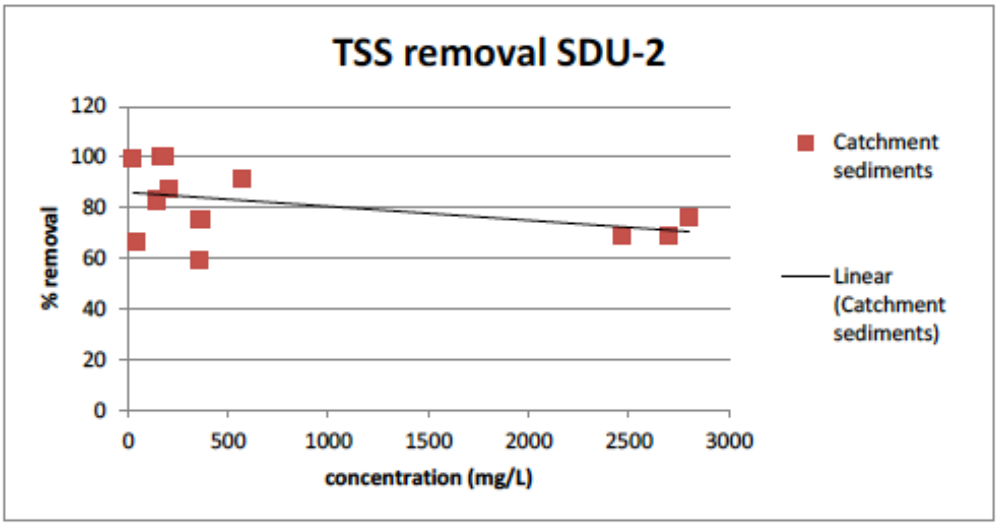


Figure 6: Test Mix A – TSS Removal

These results show a TSS average concentration removal efficiency of 81%.

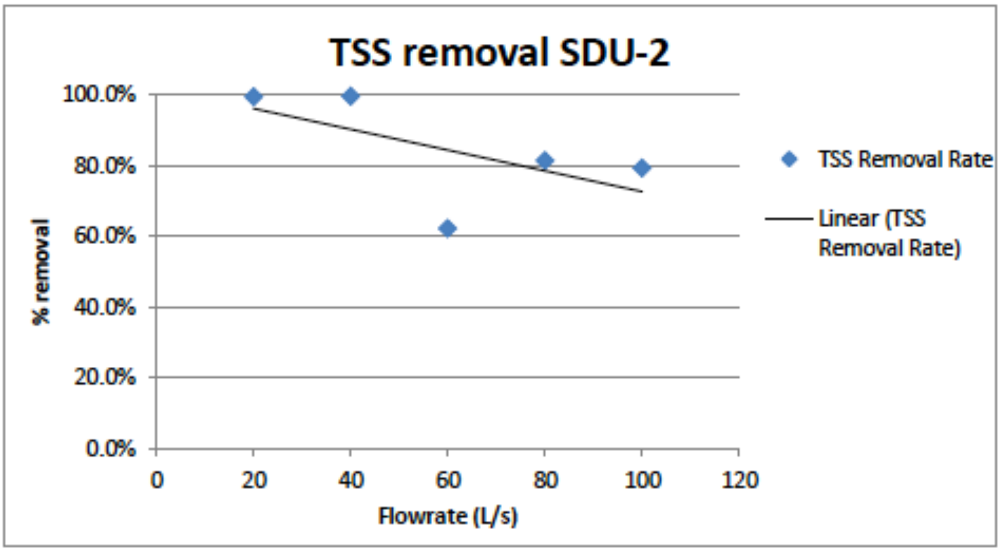


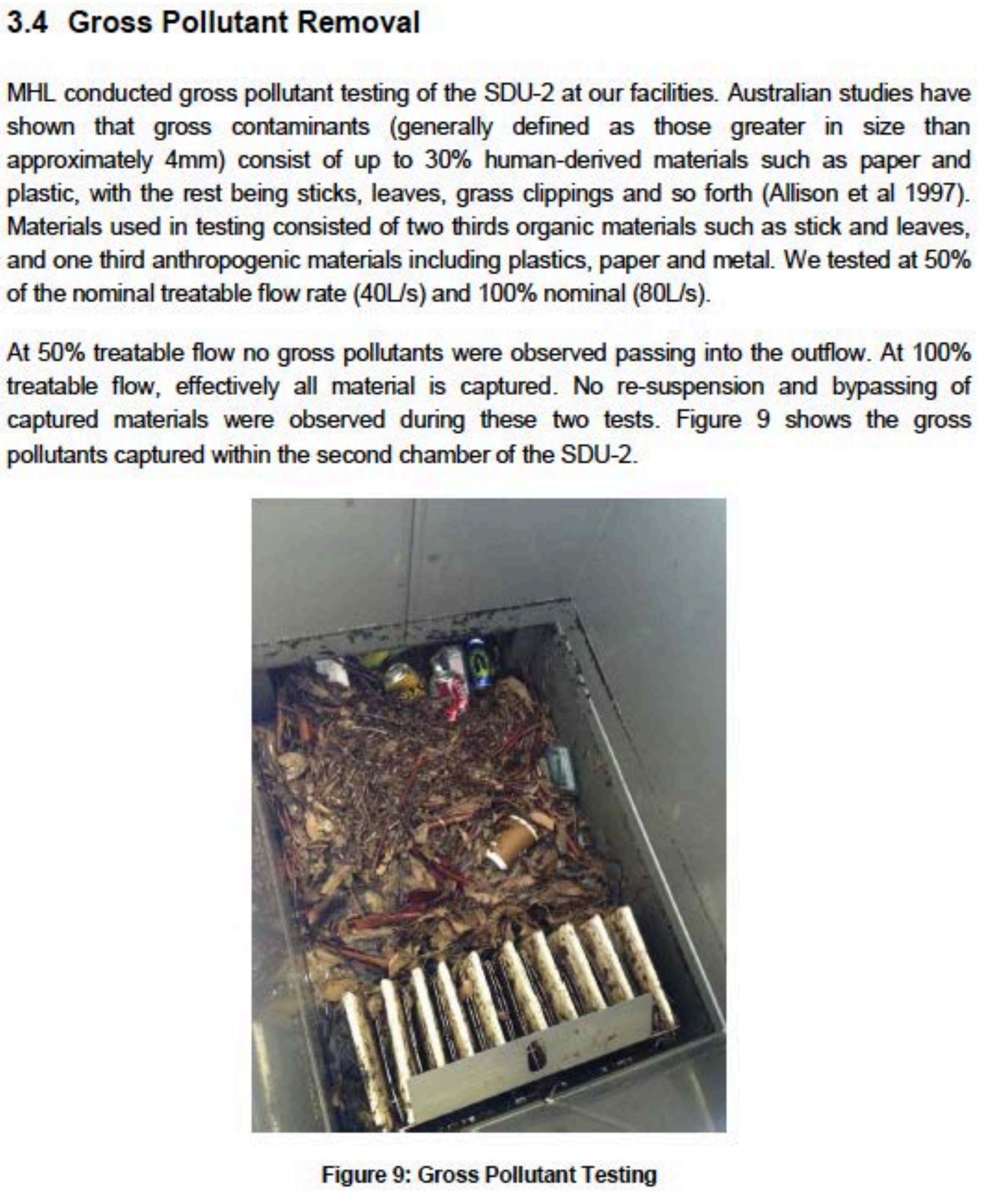
Figure 7: Test Mix B – TSS Removal

These results show a TSS average concentration removal efficiency of 86% over the nominal treatable flow range.

The gross pollutant removal test results are summarised below.

MHL staff carried out collection of gross pollutants from the local areas. The mix of materials followed the ARQ recommendation mix percentages of constituents.

Gross Pollutant removal was noted at 100% with no resuspension.



3.4 Gross Pollutant Removal

MHL conducted gross pollutant testing of the SDU-2 at our facilities. Australian studies have shown that gross contaminants (generally defined as those greater in size than approximately 4mm) consist of up to 30% human-derived materials such as paper and plastic, with the rest being sticks, leaves, grass clippings and so forth (Allison et al 1997). Materials used in testing consisted of two thirds organic materials such as stick and leaves, and one third anthropogenic materials including plastics, paper and metal. We tested at 50% of the nominal treatable flow rate (40L/s) and 100% nominal (80L/s).

At 50% treatable flow no gross pollutants were observed passing into the outflow. At 100% treatable flow, effectively all material is captured. No re-suspension and bypassing of captured materials were observed during these two tests. Figure 9 shows the gross pollutants captured within the second chamber of the SDU-2.

Figure 9: Gross Pollutant Testing

The hydraulic impedance expressed as a head loss factor ‘k’ was also measured.

The calculated head loss value k = 0.425 was consistent across flow rates of unto 150 L/sec.

This head loss ‘k’ factor is similar to typical stormwater pits, hence the inclusion of an Enviro device represents the equivalent to one addition stormwater pit in a drainage system.

3.5 Headloss Testing

Headloss characterises the energy lost as fluid runs through a hydraulic device, and may be affected by frictional losses (eg on the sidewalls), change in velocity, direction or elevation of the fluid, and turbulence within the system. It is often expressed as a value of *K*, the resistance headloss coefficient.

It is particularly important to identify the headloss of a SQID at high and bypass flow rates for stormwater system design considerations.

Headloss testing of the device shows low headloss throughout the flowrates tested (20L/s to 150L/s). The K value across these tests is 0.425 as can be seen in Figure 10.

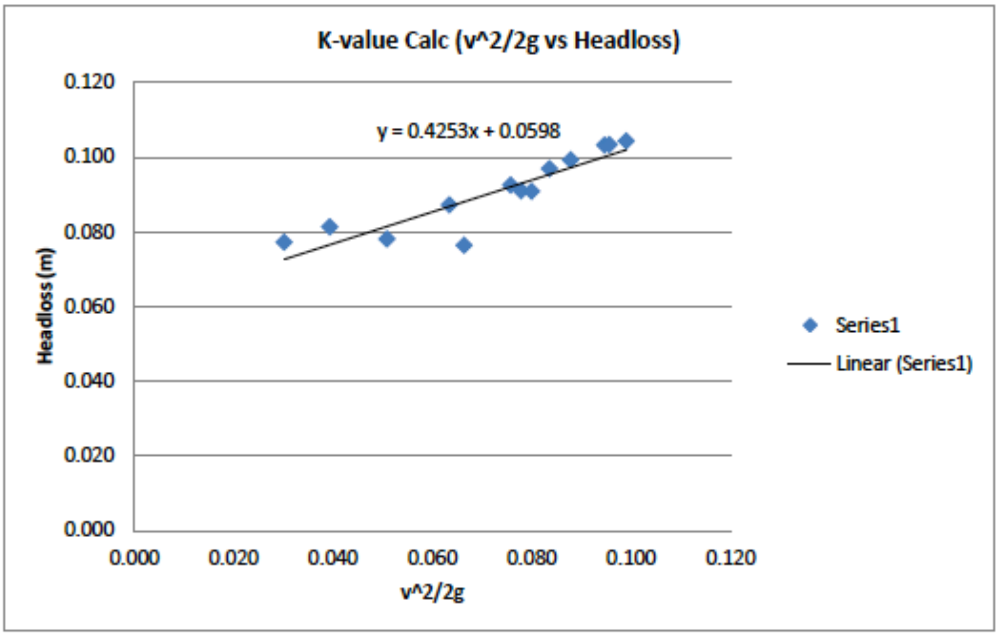


Figure 10: Headloss K Value