SQIDEP independent evaluators Supplementary Report:

SPEL Half Height Filter

DesignFlow & AECOM

July 2023

Table of Contents

1 INTRODUCTION

This report summarises the assessment undertaken by the independent evaluators of Stormwater Australia for an application by SPEL for performance verification of the **Half Height SPELFilter** device.

The performance of the Full Height SPELFilter has previously been verified by the independent evaluators as being consistent with the performance claims made by SPEL. This included the pollutant reduction factors and treatable flow rates for the Full Height Filter. Additional details of that evaluation are provided in the report "SQUIDEP Independent Evaluators Joint Report, SPELFilter" (DesignFlow and AECOM, 5 December 2022).

The performance of the Half Height SPELFilter is submitted by SPEL to be equivalent to that of the Full Height SPELFilter, except that the Half Height treatable flow rate would be half that of the Full Height filter. This was based on data included in a monitoring report "SQIDEP Body of Evidence Submission – Half Height Cartridge Supplementary Report, Sippy Downs Drive, Sippy Downs, QLD 4556" (Issue No. 1, 2 June 2022). However, it was determined by the evaluators that the treatable flow rate claimed for the Half Height filter was not clear and that additional monitoring would be necessary.

Additional data has subsequently been collected and submitted by SPEL (30 May 2023) in relation to the Half Height SPELFilter. This supplements the Body of Evidence data in the June 2022 report. The review of the above sets of data is the focus of this report and is discussed in the following sections.

1.1 Evaluators Declaration of Independence

It is declared that the evaluators, Robin Allison and Ricky Kwan, are completely independent and have no conflict of interest with respect to this engagement. They have not, nor have ever been employed or commissioned by the Applicant, SPEL.

They have not been involved in the design or development or monitoring of the SPELFilter system and have undertaken this assessment without prejudice and in good faith.

2 BACKGROUND

2.1 Available Data

Data provided and relevant for the Half Height Filter included the following documents:

- SQIDEP Body of Evidence Submission, Half Height Cartridge supplementary report, Sippy Downs Drive, (Drapper Environmental Consultants, 2 June 2022);
- ALS Chain of Custody, Certificates of Analysis, and Quality Control Reports (2020);
- Statutory Declaration by Drapper Environmental Consultants, 8 April 2022;
- Sippy Downs Drive Filter Hydrographs (1 April 2020 – 3 February 2022);
- SQIDEP Supplementary Information, Field Monitoring of a SPEL Half Height Filter at Sippy Downs Drive (Drapper Environmental Consultants, 30 May 2023);
- SQIDEP Body of Evidence Submission, SPEL Stormfilter *(full height)*, Hilton Foods, Issue 1, 1 April 2022); and

- SQIDEP Independent Evaluators Joint Report, SPELFilter *(full height)* (Design Flow and AECOM, 5 December 2022).

The first four reports for the Half Height filter in the above list were included in the package of information submitted for verification of the Full Height SPELFilter. This included information on the data monitoring equipment and process, chain of custody, certificates of analysis and quality control reports. It is noted that while the processes adopted were similar for both sets of filters, the Half Height filter was not assessed at that time as the application was specific to the Full Height SPELFilter.

The SQIDEP Supplementary Information report (30 May 2023) provides the recent field monitoring undertaken to establish the treatable flow rate for the Half Height filter. The reader may also refer to SQIDEP Independent Evaluators' Joint Report for the SPELFilter *(full height)* for additional information.

2.2 SPEL Half Height Filter at Sippy Downs Drive

SPELFilters perform water treatment as hydraulic pressure forces water upwards through the filter media and is then collected by a central tube in the filter system that discharges treated flows to an outlet pipe (Figure 1).

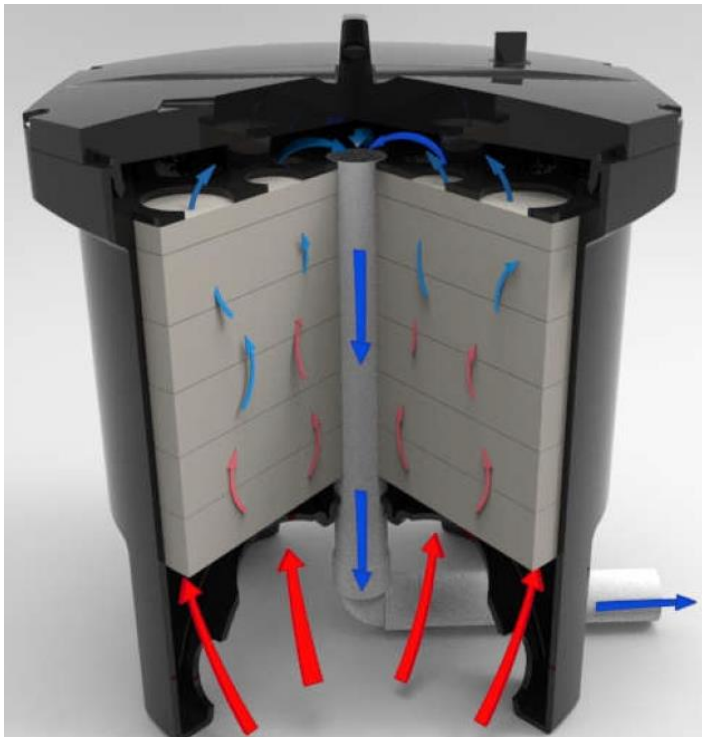

Figure 1: SPELFilter schematic from SPEL Stormwater (2022)

The Sippy Downs monitoring site is located at Sippy Downs Drive, Sippy Downs Queensland (Figure 2). The site has a catchment area of about 808 m^2 and consists mostly of urban paved surfaces. The treatment train design consisted of the following components:

- Underground filter vault with 6 x Half Height SPELFilters. Each filter is 474mm in height and 726mm in diameter with a 726 mm octagonal lid (Figure 3);
- Surface runoff drains into the filter vault via a kerb entry inlet (Figure 4);

- Treated stormwater is discharged via filter outlet pipes to the flow measurement pit and then released to the street drainage network; and
- Bypass flows are designed to back up in the inlet area and overflow into the adjacent pit.

Figure 2: Sippy Downs Drive Half Height Filters Monitoring Site

Figure 3: Sippy Downs Drive Filter Vault

Figure 4: Sippy Downs Half Height Monitoring Equipment Arrangement

Monitoring was conducted following the SQIDEP protocols by monitoring rainfall, flow rates and collecting water quality samples at the inflows to the vault (containing the cartridges) and of the treated outflow pipe (from the filters). The flow monitoring equipment and approach included the following:

- Starflow QSD flow meter for measurement of flowrate (depth and velocity) at the inlet;
- WL705 Ultrasonic sensor and Global Water 4" Palmer-Bowlus flume for the measurement of outflow at the outlet chamber (900 x 900 precast pit). The Starflow QSD flowmeter was not used for the measurement of outflow due to the physical limitations of the downstream pipe system at the precast pit outlet chamber;
- Stainless steel water level float and switch to indicate when bypass flows occur;
- Rainfall was measured using a ClimaVue weather station and logged every 10 seconds; and
- Flow measurement was undertaken continuously and logged every 10 seconds during flow periods and logged every 10 minutes during no-flow periods.

A total of 25 qualifying and partially compliant events were recorded for the sampling period between 9 March 2020 to 3 February 2022. This reduced to 15 fully compliant events when the partially compliant events were excluded from the dataset. For these events, water quality samples were flow weighted automated samples, with at least eight aliquots collected per event from inflow and outflows.

An additional 12 events were monitored for the sampling period between the 16 January 2023 to 14 May 2023. For these events, only the rainfall, inflow and outflow rates were monitored. Water quality sampling was not undertaken.

2.3 Performance claims

The performance treatment claim for the Half Height SPELfilter is shown in Figure 5. This is the same as that for the Full Height filter.

Parameter	Claim (%)
Total Suspended Solids (TSS)	85
Total Phosphorus (TP)	74
Total Nitrogen (TN)	59
Gross Pollutants (GP)	-

*Mean of Average Concentration Removal Efficiency (CRE) and Efficiency Ratio (ER)

Figure 5: Water quality performance claims by SPEL

The claimed treatable flowrate for the Half Height filter is 1.5 L/s per cartridge. This equates to a total treatable flowrate of 9 L/s for the 6 Half Height filters adopted for the Sippy Downs site.

It is noted that for the Hilton Foods site, where the Full Height filters were monitored, there was no clear statement of the treatable flow rate, but it was inferred that the Full Height filters have a capacity of 3 L/s per cartridge.

3 SQIDEP COMPLIANCE

3.1 SQIDEP assessment

The minimum requirements from SQIDEP are reproduced in Table 1 and are evaluated against the data provided with the applicant's submission.

Table 1 SQIDEP Compliance for Half Height SPELFilter

Criteria	Requirement	Evaluation finding	Compliance Status
Organisational Roles and Quality Assurance			
Organisational Roles and Responsibilities	The claimant, sampling organisation, analytical laboratory and reporting organisation shall be clearly identified (especially in confirming independence requirements	Organisational chart provided defining roles and responsibilities. SPEL stormwater engaged Drapper Environmental Consultants to undertake monitoring. ALS Environmental undertook laboratory sample analysis. SPEL undertook maintenance which included cleaning of filter vault once every 6 months. No other maintenance or replacement of SPELFilters was performed. For the January to May 2023 monitoring period, maintenance included the removal of material that had fully blocked the inlet pipe after the flow event had ended.	Compliant
Sampling QA and Quality Control	Operation and maintenance schedules for sampling equipment shall be provided. Chain of custody documents identifying sample, collection agency, collection time, preservation used and laboratory receipt of sample and sample condition shall be provided.	ALS laboratory performed random blanks and duplicate testing as part of Quality Control. Records provided in Appendices. Chain of custody and sample preservation documented.	Compliant
Reporting	By independent organisation	Reported by Darren Environmental Consultants	Compliant
Sampling Events			
Type of Event	Rainfall Events	Real storm events were sampled	Compliant
Minimum Number of Events	The greater of: a. 15 events, and b. Sufficient events to achieve 90% confidence interval.	25 qualifying and partially compliant events, reduced to 15 fully compliant events over 12 months (March 20 to February 2022) for TSS, TP, and TN samples 12 events for rainfall, inflows and outflows (excluding water quality sampling (January to May 2023)	Compliant
Measuring Rainfall	Rainfall shall be measured by a rain gauge capable of sampling at intervals of 5 minutes or less, and in increments no greater than 0.25mm	Minimum storm duration of 5 minutes recorded by electronic weather station (March 20 – February 2022 sampling)	Compliant
Minimum Rainfall Depth	Sufficient to collect minimum sample volume (based on laboratory analytical requirements).	All were above 5mm.	Compliant
Recommended Inter-event Time	Min 6 hours	Continuous distribution of rainfall events over 12 months with at least six hours between events	Compliant

Device Size	Full scale	Device is full scale.	Compliant
Runoff Characteristics	Target pollutant profile of influent and effluent	They are representative	Compliant
Runoff Volume or Peak Flow	At least 2 events should exceed 75% of the design water quality volume/ TFR and 1 event greater than 100% of the TFR.	8 of the fully compliant events exceeded the total treatable flow rate of 9 L/s for the March 20 to February 2022 monitoring period The treatable flow rate of 9 L/s was reached on 12 occasions for the January to May 2023 monitoring period, of which 2 were in bypass	Compliant
Sampling Procedures and Techniques			
Automated Sampling	Composite samples on a flow- (preferred) or time-weighted basis	Samples were collected on a flow-weighted basis and were composited before being split into sub-samples for analysis	Compliant
Minimum Number of Aliquots	80% of field test collections should have at least 8 per event. Notwithstanding aliquots should be collected to provide hydrograph coverage of rising and falling limbs.	Number of aliquots significantly exceeds 8 for all events Events where significant parts of the hydrograph were missed were not included in the analysis.	Compliant
Hydrograph coverage	At least 50% of qualifying storms should include the first 70% storm hydrograph coverage (or, for storms longer than 8 hours, capture of the first 8 hours). Programs should aim to capture full hydrographs for all events, but flexibility will be considered for large volume, long duration events. Dependent on catchment and rainfall patterns, multiple peaks should be accounted for (at least 1 occurrence).	The sampling covered a suitable range of events including multi-peak hydrographs.	Compliant
Seasonality	Events to be distributed to capture seasonal influences	All seasons are covered by the data set	Compliant
Grab Sampling	Only for constituents that transform rapidly, require special preservation or adhere to bottles, or where compositing can mask the presence of some contaminants through dilution.	NA	NA
Sampling Location	As identified and agreed in the submitted QAPP.	Sampling undertaken at influent and effluent using suction lines. Effluent sampling was for treated flows only and did not include bypass flows. Locations appear to be appropriate and representative.	Compliant
Sampling Procedures and Techniques			
Chemical and Physical analytes	As identified and agreed in the submitted QAPP.	Dissolved nutrients as well as totals were analysed.	Compliant

Minimum and maximum (influent) pollutant concentrations for qualifying events	Minimum concentrations: exclude if below limit of detection. Maximum: mean+2SD for any single event, and mean +1SD in the aggregate dataset. Refer SQIDEP Table 1.	All influent concentrations are below the maximum concentrations permitted.	Compliant
Analytical Methods	NATA accredited sample handing and analytical methods. Refrigerated autosamplers may be required to adequately preserve samples.	Laboratory is NATA accredited and COC forms provided.	Compliant
Requirements			
Flow Measurement Location	Inlet, Outlet and Bypass, as applicable. Based on relevant accepted measurement protocols for flow type (e.g. open channel, in pipe)	Flow measurement locations are appropriate, no water level depths in the vault were presented.	Compliant
Precipitation Measurement	Automatic rain gauge (pluviometer)	ClimaVue weather station logged every 10s	Compliant
Recording Intervals	5 minutes or less	Complies	Compliant
Rainfall Recording Increments	No greater than 0.25mm	Complies	Compliant
Rain Gauge Calibration	Twice during monitoring period	Report states that calibration was completed by the manufacturer in the workshop every 2 years and did not require re-calibration during the monitoring period.	N/A
Data Analysis and Reporting			
Performance Indicators	Based on the Performance Claim stated in Detailed Performance Report. (Can include but not limited to TSS, Metals, TPH, TP & TN). The target pollutants and testing rationale must be described in the QAPP & Detailed Performance Report. Where a device is claiming total reductions of a particular pollutant, it is not necessary to include speciation. If speciation is not undertaken then reductions of sub-species cannot be claimed.	The performance claims relate to TSS, TP and TN which were included in the suite of parameters plus dissolved nutrient species. Gross pollutants not claimed, however device would be effective at gross pollutant capture until such time as bypass is engaged, at which point floatable gross pollutants may overflow from the device.	Compliant
Performance Indicators Calculation	Concentration Removal Efficiency (CRE) (See Section 6.4.3) (Arithmetic average and median. If difference is 10% or greater, inspect data set closely) Mass Removal Efficiency (MRE) (See Section 6.4.4) (Arithmetic average and median. If difference is 10% or greater, inspect data set closely)	Sufficient data analysis was presented for Concentration Removal Efficiency and Efficiency Ratios. Reports may choose to present some, or all, of the metrics; however, as a minimum CRE and ER shall be provided. The data presented is considered adequate to assess the performance claims.	Compliant

	Relative Achievable Efficiency (RAE) (See Section 6.4.5) (Arithmetic average and median. If difference is 10% or greater, inspect data set closely Summation of loads (SoL) (See Section 6.4.6) (Arithmetic Average and median. If difference is greater than 10% inspect dataset closely) Efficiency Ratio (ER) (See Section 6.4.7) (Arithmetic Average and median. If difference is greater than 10% inspect dataset closely) Flow Based Variability (FBV) (See Section 6.4.8), including a plot of one of the above performance measures against the 25, 50, 75, 100 and 125 percent of the treatable flow rate. Provide details on the selected curve and the associated R^2 value.		
Performance Variability	Box and Whisker Plots of inlet and outlet EMCs.	Provided	Compliant
Statistical Significance Testing	Log-transformed inlet and outlet paired samples at 90% confidence level.	Provided	Compliant
Sizing Methodology	A sizing methodology must be provided that allows an evaluation of performance of other devices in a 'family' to be reviewed. This should include relationships established under defensible theoretical/ modelled conditions or testing undertaken under either field or laboratory conditions.	Sizing approach using MUSIC was provided. Note that the assessors recommend modification to the MUSIC modelling approach compared to that claimed.	Compliant

3.2 Treatable Flow Rate

The May 2023 report included hydrographs for inlet and outlet flow rates for 12 rainfall events. Several of the rainfall events monitored were multi peak storms (Figure 6), while others were essentially single peak storms (Figure 7).

As mentioned in the May 2023 report, the filters reached a peak outflow rate of 9 L/s on 12 occasions of which 2 were in bypass. For the 6 Half Height Filters used in the monitoring, this equates to a treatable flow rate of 1.5 L/s per cartridge and is therefore consistent with the claimed treatable flow rate of 1.5 L/s per cartridge.

It is noted that some of the inflow rates indicate high variability and noise. In a few cases it also appears that the measured inflow is higher than the outflow at the start of the storm event, which is surprising (eg 10 February 2023). This may indicate antecedent rainfall not monitored or prior storage in the vault.

Overall, however, on the basis of the results presented, it is agreed that the Half Height filters have a treatable flow rate of about 1.5 L/s per cartridge.

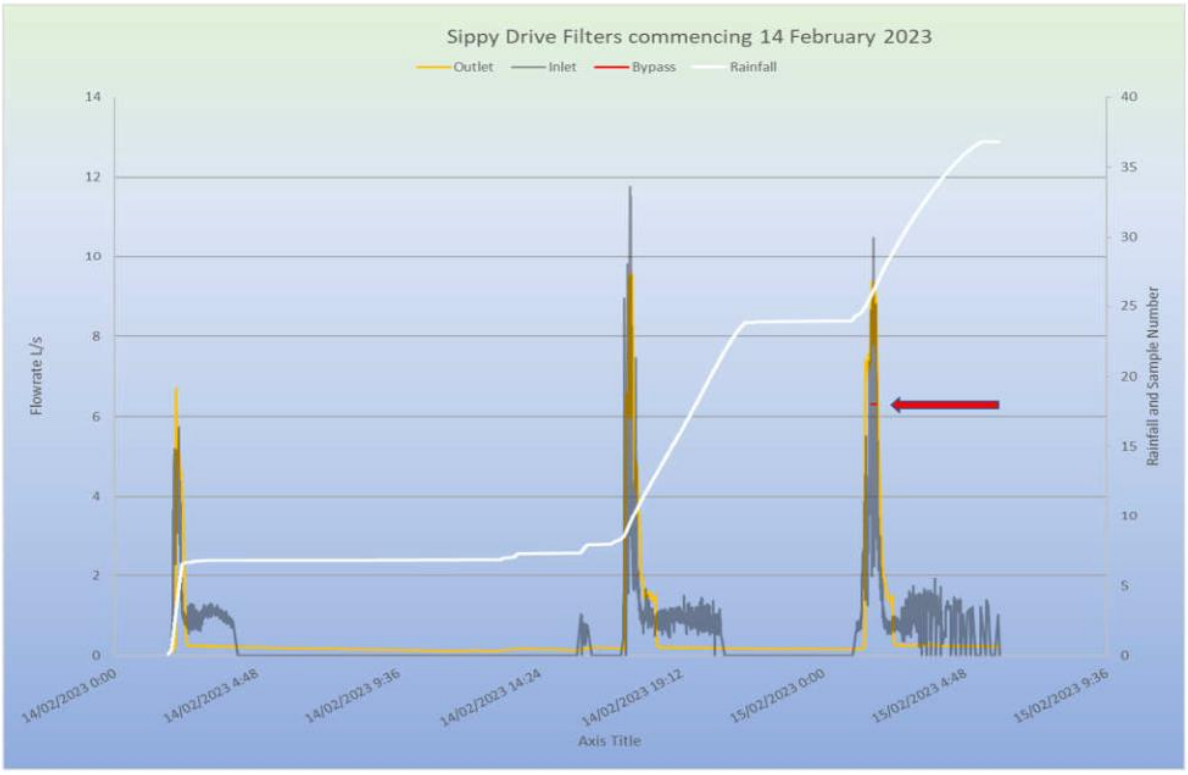

Figure 6: Hydrograph for rainfall event of 14 February 2023

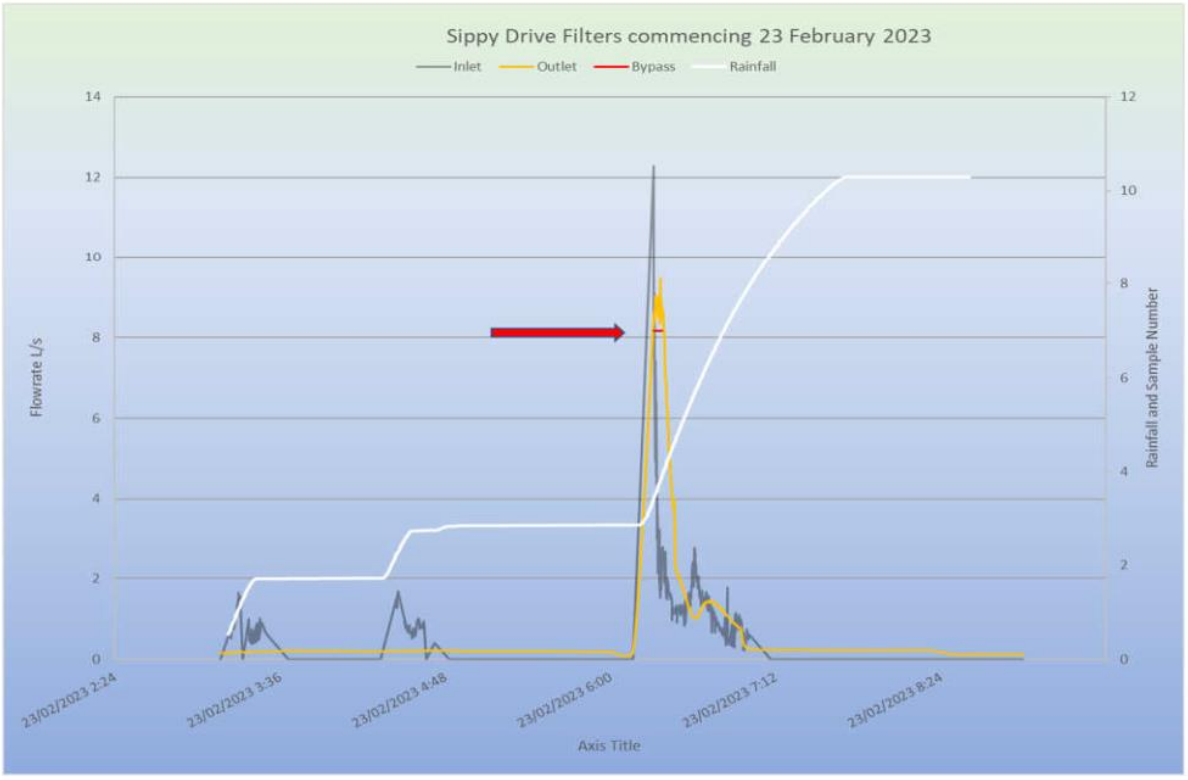

Figure 7: Hydrograph for Rainfall Event of 23 February 2023

3.3 Pollutant removal and statistical analysis

A review of the analysis and approach undertaken for the Half Height filter indicates that it was robust. The reviewers therefore have no objection to what is presented nor to the claims of water quality improvements for flows up to the treatable flow rate.

It is noted that the approach adopted for the Half Height filter was consistent with that for the Full Height filter, which was also reviewed by the assessors to be robust and compliant with SQIDEP V1.3.

4 DISCUSSION

4.1 Overall performance assessment

The assessors are generally comfortable with the approach to the monitoring program, the installation of the field site, the number and variation of flow events monitored and the data analysis. This includes the monitoring undertaken for both the March 2020 – February 2022 and January to May 2023 periods.

It is our opinion this program does reflect the field performance of the Half Height Filter stormwater treatment system at the Sippy Downs Drive site.

4.2 Gross Pollutant Removal

It is important to note that the treatment system adopted for the Sippy Downs Drive site did not include any pre-treatment at the inlet to the filter vault. This differs to that adopted for the Hilton Foods site for the Full Height Filter, which included pre-treatment through the use of SPEL

Stormsacks. The Stormsacks provided pre-treatment through the removal of gross pollutants prior to inflows into the filter vault.

As noted in the Sippy Downs Drive reports (June 2022, May 2023), blockage from heavy sediment and leaf litter loads occurred during both monitoring periods, which led to operational difficulties and the need for removal of these litter loads during or after storm events.

On the basis of the above accounts, it is considered that maintenance of the inlet conditions or provision of a gross pollutant removal device at the inlet to the filter vault is integral to the performance of the Half Height Filter.

4.3 MUSIC node inputs

The MUSIC node modelling approach proposed by SPEL for the Half Height Filter (Sippy Downs, June 2022) is essentially the same as that for the Full Height report (Hilton Foods, April 2022).

However, as discussed in the evaluators report for the Full Height Filter (December 2022), it is recommended that the approach be modified to ensure there is no potential elevated removal efficiencies attributed to flow storage in the vault.

For consistency, the same modified MUSIC node approach is recommended for the Half Height SPELFilter as follows:

1. Use a detention basin node to represent the vault (with modified 'K' values and nominal detention time set to the treatment flow rate of the cartridges):
    - modified 'K' values with K=1
    - use size of 0.5m^2 per cartridge and 0.5m extended detention depth
    - adopt a nominal detention time of 0.1 hours (plus or minus 10%).
2. Use a generic node with the monitored pollutant reduction values and have a high flow bypass of 1.5 L/s per cartridge:
        - a high flow bypass of 1.5 L/s per cartridge
        - pollutant reductions of 85% for TSS
        - pollutant reductions of 74% for TP
        - pollutant reductions of 59% for TN.

When entering the data into MUSIC the detention basin surface area and high flow bypass rate of the generic node is factored up depending on the number of filter cartridges proposed. All other values listed above remain the same (note: the *Notional Detention Time* is adjusted by changing the *Low Flow Pipe Diameter*).

Additional details may be referred to in the evaluators report for the Full Height SPELFilter (December 2022).

5 CONCLUSION

This assessment has considered a Body of Evidence and Supplementary Information submitted by SPEL for the purposes of assessing the pollutant treatment performance of the Half Height SPELFilter.

The evaluators are in general agreement with the approach and execution of the monitoring program, as well as the pollutant reduction factors and treatable flows claimed by SPEL for the Half Height Filter.

It is noted that pre-treatment of the inflows using a gross pollutant trap or similar is essential to the operational performance of the filter. A revised method of representing the monitoring results for use in a MUSIC node is also recommended.

6 REFERENCES

SPEL Environmental, 2022. SPELFilter Technical Drawings

Stormwater Australia (2019) *Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) V1.3*