SQIDEP independent evaluators joint report:

SPELFilter

DesignFlow & AECOM

22 December 2022

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1 INTRODUCTION

This document reports on the independent evaluation of an application by SPEL for performance verification of the SPELFilter device by Stormwater Australia. The independent evaluation has been undertaken following the requirements of the Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) V1.3 (Stormwater Australia, 2019).

SPEL have requested evaluation under the 'Body of Evidence' pathway set out by SQIDEP.

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 has he 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. They have undertaken this assessment without prejudice and in good faith.

Dr Robin Allison

Dr Ricky Kwan

5 December 2022

2 BACKGROUND

2.1 Review documents and data

The following documents were relied upon for this evaluation report:

- SPEL Body of Evidence application submission prepared by Drapper Environmental Consultants, 4 April 2022
- Statutory Declaration by Drapper Environmental Consultants, 8 April 2022
- Hydrographs of compliant and partially compliant events at the Hilton Foods site showing inflow, outflow, rainfall and samples collected (42 items)
- Sample collection and/or reset emails/site records at the Hilton Foods site (50 items)
- Laboratory Chain of Custody forms, Quality Control reports, QC Compliance Reviews & Certificates of Analysis
- Subsequent hydrograph plots for Hilton Foods site that included monitored outflow rates (and summary table of results) – (37 items), 17 October 2022.

2.2 SPELFilter at Hilton Foods monitoring site

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).

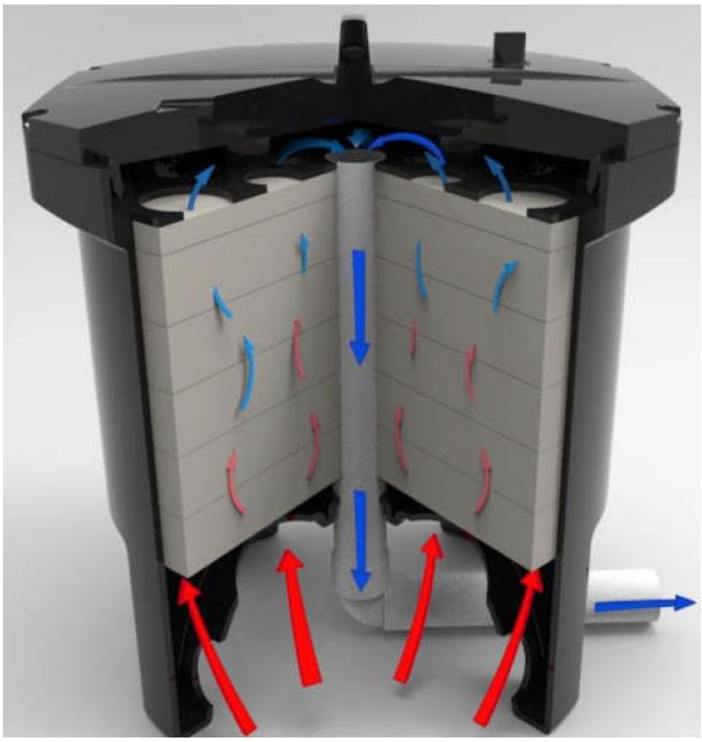

Figure 1 SPELFilter schematic from SPEL Stormwater (2022)

The Hilton Foods is located in Heathwood, Queensland and the site has an area of approximately 7.7 hectares with a mix of roof, hardstand and landscaped area (Figure 2). It is considered to be representative of generating typical pollutant loading from a light industrial land use.

The treatment system at Hilton Foods comprises of:

- Pit insert “SPEL Stormsacks” (for coarse material capture)
- 29 SPELFilter cartridges 850mm high (Model SF 30 EMC-M) housed within a “vault”.

Outflows from the SPELFilters flow into an on-site detention tank.

Figure 2 Hilton Foods SPELFilter monitoring site

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). Flow monitoring involved Starflow ultrasonic flow meters that measure flow depth and velocities and water depths were measured in the vault to determine whether the vault overflowed.

Water quality samples were flow weighted automated samples, with at least eight aliquots collected per event from inflow and outflows.

No monitoring of the flow or water quality data were presented for overflows (i.e. bypass flows) from the vault.

Two field sites were presented in the Body of Evidence – Hiton Foods and ALDI – however, it was agreed with the proponents that the assessment would only be conducted for the Hilton Foods site because it had more continuous monitoring results and the installation of the SPEL *Stormsacks* represent the recommended approach to the treatment train for SPELFilters.

2.3 Performance claims

The Body of Evidence states the following performance claims for water quality improvement (Figure 3):

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 3 Stated water quality performance claims by SPEL

There is no clear statement of claimed treatment flow rate, but it is inferred from the design flow rate noted in the description of the device, that the hydraulic capacity is 3 L/s per cartridge. This equates to a treatable flow rate of 87L/s at the Hilton Foods site (with 29 cartridges).

2.4 MUSIC node claims

The applicant proposes the following approach to modelling SPELFilter in MUSIC:

1. Use a detention basin node to represent the vault (with modified ‘K’ values and nominated size of 1m^2 per cartridge and 0.85m extended detention depth)
2. Use a generic node with the reduction pollutant reduction shown in Figure 4 and have a high flow bypass of 3 L/s per cartridge.

Table 23. Summary of MUSIC Node Pollutant Concentration Inputs

Pollutants	Inlet Concentration	Outlet Concentration	Claim (%)
Total Suspended Solids, TSS (mg/L)	1000	150	85
Total Phosphorus, TP (mg/L)	5	1.3	74
Total Nitrogen, TN (mg/L)	50	20.5	59
Gross Pollutants, GP (kg/ML)	-	-	-

Table 24. Summary of SPELFilter Vault MUSIC Node k value Inputs

Pollutants	Detention Basin Default k values	Rainwater Tank Default k values	Proposed SPELFilter Vault k values
Total Suspended Solids, TSS (m/yr)	8000	400	4200
Total Phosphorus, TP (m/yr)	6000	300	3150
Total Nitrogen, TN (m/yr)	500	40	270

Figure 4 Claimed MUSIC node parameters

The outcome of the assessors' review does not agree with this approach and an alternative approach for inputs to MUSIC are provided in Section 4.3

3 SQIDEP COMPLIANCE

3.1 SQIDEP assessment

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

Table 1 SQIDEP Compliance

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 12 months. No other maintenance or replacement of SPELFilters was performed.	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.	37 qualifying and partially-compliant events over 13 months. 6 events were not included in the analysis of results because portions of the hydrographs had no samples taken. A few events were removed from the analysis for particular components resulting in 31 events for TSS, 28 for TP and 29 for TN compliant events)	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 a 0.2mm tipping bucket pluviometer	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 13 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.	Of the 37 events 33 had inflows above the claimed treatable flow rate and 19 triggered overflows from the vault.	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 multiple peaked 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	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

concentrations for qualifying events			
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)	Two tipping-bucket rain gauges were used	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 performed by Drapper Consultants	Compliant
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) 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	Sufficient data analysis was presented for Concentration Removal Efficiency and Efficiency Ratios, however no mass balance was presented (as overflow from the device was not presented). The data presented are considered adequate to assess the performance claims.	Compliant

	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 Monitoring of flow rates

The initial body of evidence did not include flow rates for the outflow from the filters. These data were sought and following some discussions were provided. The flow rates were estimated by using the monitored flow velocity and flow depth when the outflow pipe was less than full. When the flow meters measured flow depth to be at pipe full depth, readings became scattered, therefore, the approach was to use monitored flow velocities and use the physical pipe cross-section area for all times when the depth was measured as being deeper than the pipe diameter.

This approach was discussed with the applicant and the assessors were satisfied this approach to be robust with the updated flow information provided by the applicant following agreement of the approach.

A sample of a measured hydrograph provided by the applicant including the treated outflow rate (yellow) is presented in Figure 5

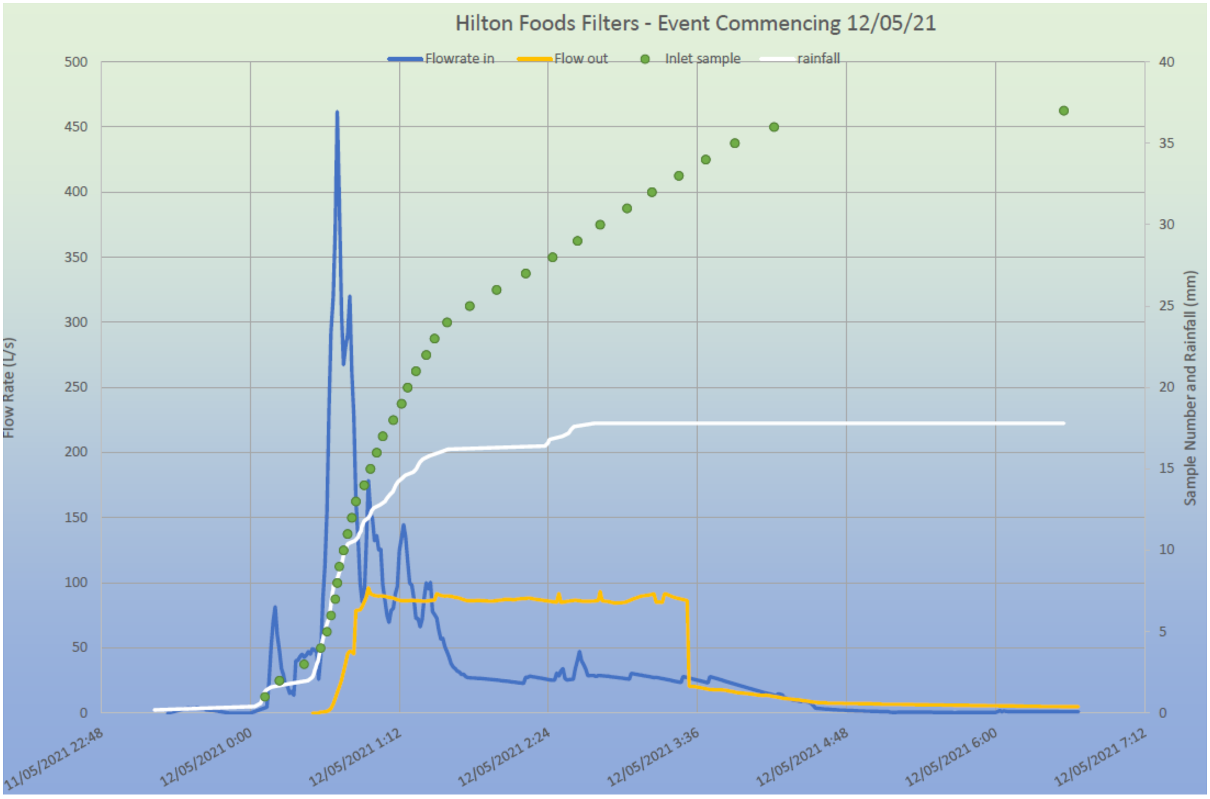

Figure 5 Example monitored hydrograph from Hilton Foods site

Flow data from the outflow of the cartridges is a critical component of the performance of the treatment system. It represents the treatable flow rate to which the pollutant reduction claims apply. It is also a critical input to MUSIC when assessing the performance of a treatment trains.

The monitored flow data (both inflows and outflows) do vary and in some cases show non-logical trends. This is to be expected with any monitoring data and particularly when using ultrasonic devices. Overall, the quality of the flow data presented is considered to be of appropriate quality and demonstrates the general performance of the devices.

Having reviewed the hydrographs provided, the assessors are comfortable that the treatable flow rates monitored (i.e. the plateau of the outflows) confirm the theoretical treatable flow rates of 3 L/s per cartridge (i.e. 87 L/ for the 29 cartridges at Hilton Foods site).

3.3 Pollutant removal and statistical analysis

A review of the Body of Evidence suggests the analysis and approach taken was robust and the reviewers have no objection to what is presented nor to the claims of water quality improvements for flows up to the treatable flow rates.

4 DISCUSSION

4.1 Overall performance assessment

The assessors were 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.

It is our opinion this program does reflect the field performance of the SPELFilter stormwater treatment system at the Hilton Foods site in Queensland.

4.2 Treatment train

It is important to note that the treatment system assessed includes the following treatment train:

- Installation of SPEL *Stormsacks* in all inlet pits of the catchment (to capture debris)
- A vault (or detention basin) to house the filter cartridges and regulate flows through the filters (with the vault volume sized to be $0.85m^3$ per cartridge filter)
- Installed filter cartridges within the vault (with a treatment capacity of 3L/s per cartridge).

To adopt the results of this monitoring program and this assessment, the same treatment train approach must be adopted (including the relative size of the vault to the number filter cartridges). It is understood this is the general approach the applicant takes when designing treatment systems for potential installations.

4.3 MUSIC node inputs

The proposed method of modelling the performance of this system in MUSIC is not fully supported as it ‘double counts’ the performance of the vault resulting in elevated removal efficiencies compared to those monitored (particularly for TSS). A modified approach which should be used when designing SPELFilter systems is proposed below.

The monitoring program took samples from upstream and downstream of the combined system of the vault <u>and</u> filter cartridges. Therefore, the MUSIC model needs to reflect this.

While the vault contributes an important buffering role in regulating flows into the filter cartridges, its water quality treatment performance is included in the reduction values nominated in the generic node (i.e. the generic node reduction values represent the combined effects of the vault and cartridge filters).

Therefore, it is recommended to model the vault with the detention buffering function without water quality treatment because the water quality improvement performance is accounted for in the downstream generic node.

The recommended approach to modelling a SPELFilter in MUSIC is 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)
2. Use a generic node with the monitored pollutant reduction values and have a high flow bypass of 3 L/s per cartridge.

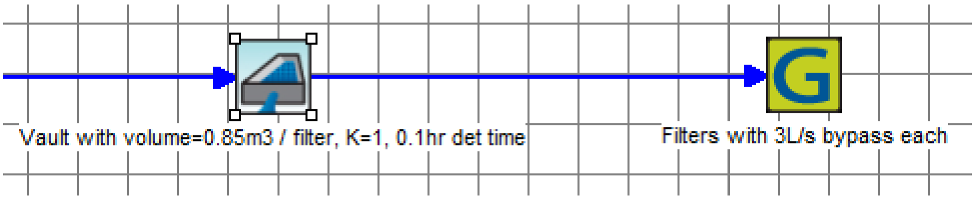

Figure 6 Recommended layout for MUSIC model

Particular inputs to the detention basin and generic nodes are listed below and shown in Figure 7 and Figure 8.

1. Use a detention basin node to represent the vault
   - with modified 'K' values with K=1
   - use size of 1m^2 per cartridge and 0.85m extended detention depth
   - adopt a nominal detention time of 0.1 hours (plus or minus 10%).
2. Use a generic node with:
   - a high flow bypass of 3 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*).

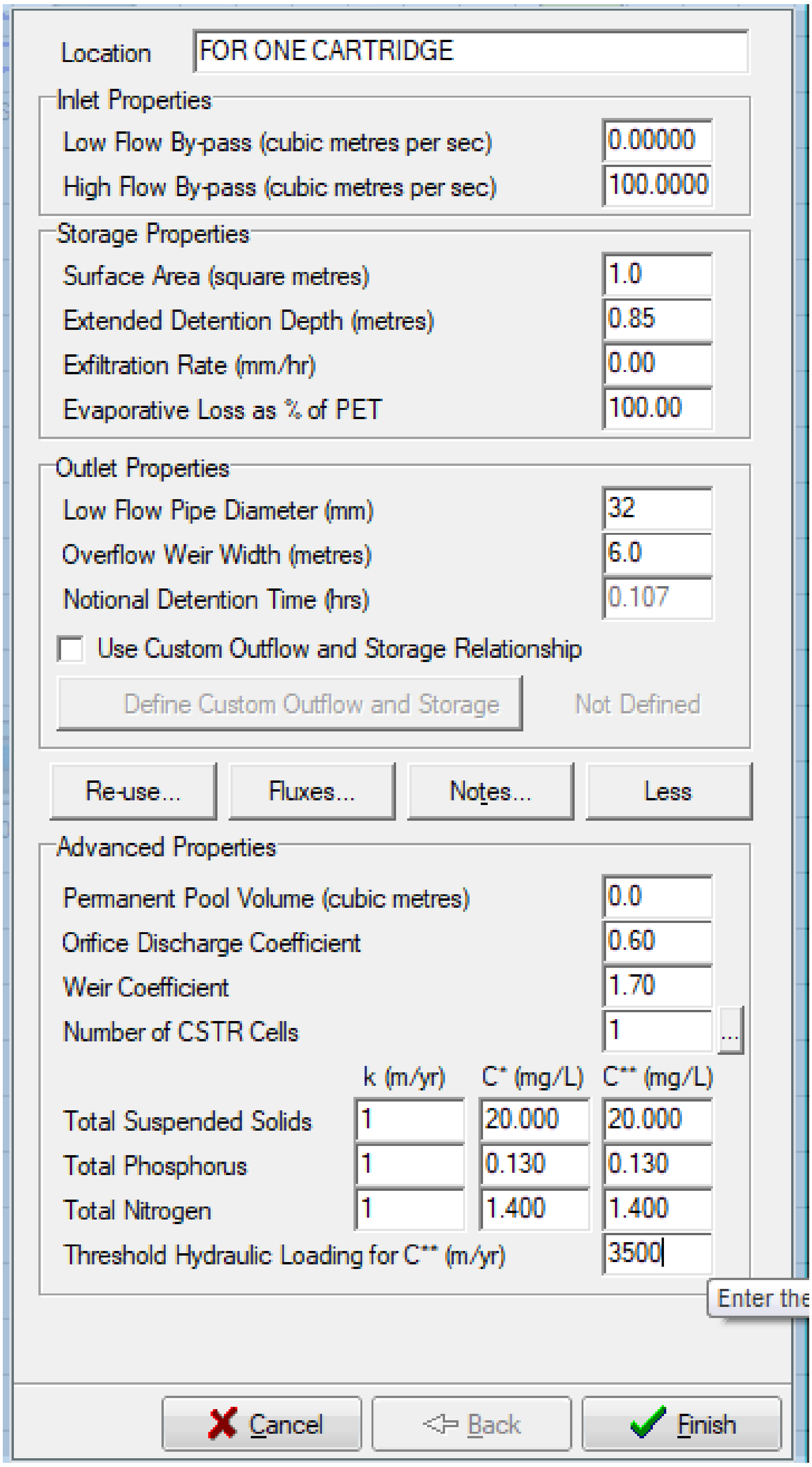

Figure 7 Recommended input parameters for detention basin node (flow rate is per filter cartridge)

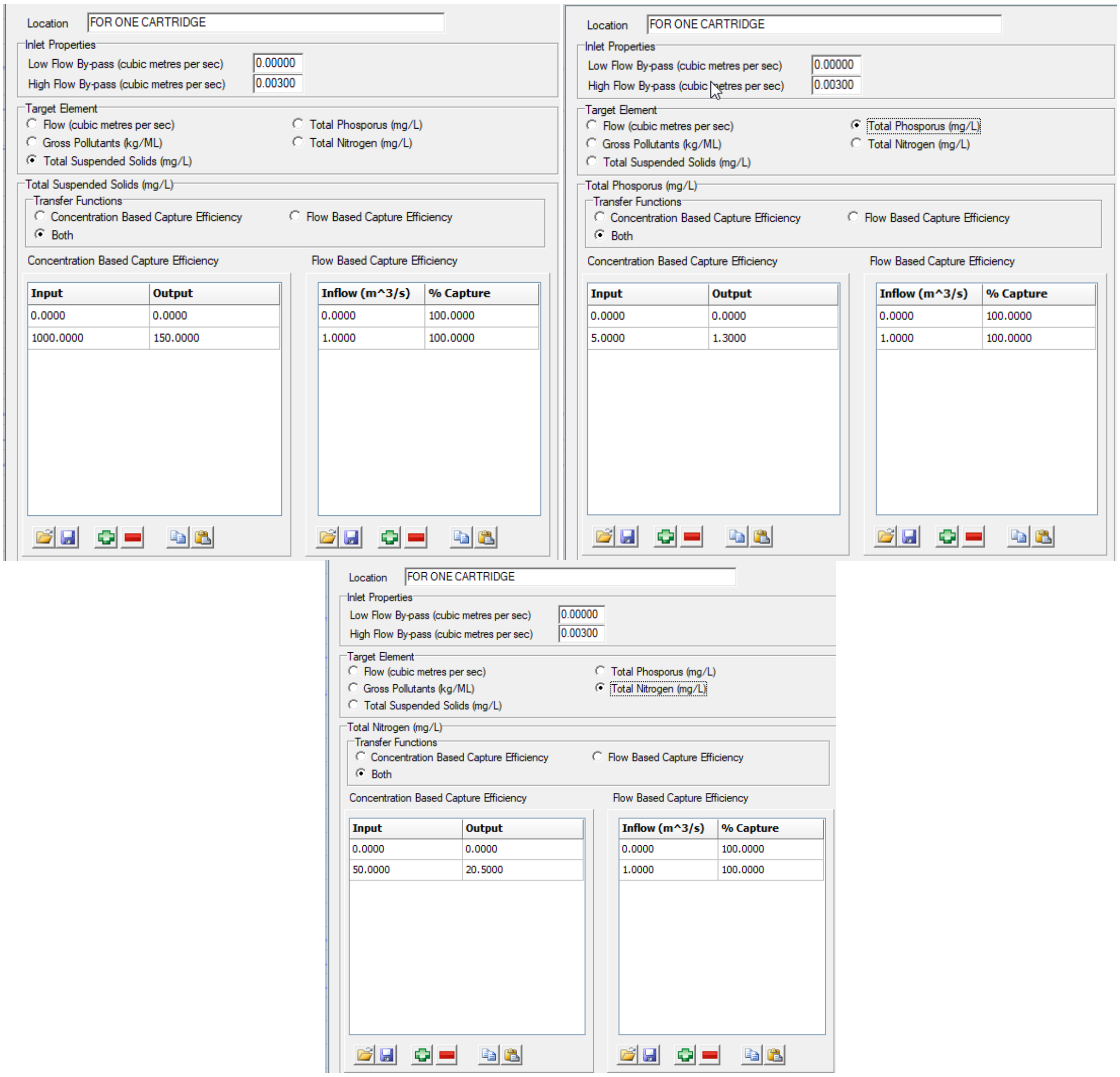

Figure 8 Recommended input parameters for generic node (flow rate is per filter cartridge

5 CONCLUSION

This assessment has considered a Body of Evidence submitted by SPEL for the purposes of assessing a SPELFilter.

The outcome of this assessment is general agreement with the approach and execution of the monitoring program as a fair assessment of the field performance of the SPELFilter. The pollutant reduction factors claimed and the treatable flows rated proposed are agreed with.

There was not full agreement of how these results were proposed to translate to a MUSIC modelling approach. A revised method of representing the monitoring results for use in a MUSIC model is provided in this report.

6 REFERENCES

SPEL Environmental, 2022. SPELFilter Technical Drawings

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