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Developing MUSIC Model Input for Simulating the Performance of the Enviro Australis Enviro EPS 450 Stormwater Treatment Device

Job No. A1707014

Prepared for Enviro Australis

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Version History

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Contents

Summary

Enviro Australis have developed several products for the removal of pollutants from stormwater, including the Enviro EPS 450 product. In 2014, a series of pollutant removal performance tests were undertaken on the Enviro EPS 450 by Enviro Australia, Ecological Consultants Australia, SESL Australia and Manly Hydraulics Laboratories (MHL). The Australian Flow Management Group (AFMG) at the University of South Australia was approached by Enviro Australis to develop a 'MUSIC' model node suitable to represent the performance of the Enviro EPS 450 product with an 80 L/s nominal treatment flow capacity based on the current body of performance test data.

Three potential means by which to simulate the performance of the Enviro EPS 450 were examined, all of which were based on the gross pollutant trap node in MUSIC. These included the following options:

1. Simulation of pollutant removal as a function of stormwater inflow rate, based on a dataset reported by MHL
2. Simulation of pollutant removal as a function of stormwater inflow rate, based on a normalised dataset provided by Enviro Australis
3. Simulation of pollutant removal as a percentage removal, based on a dataset reported by MHL.

The three options were examined to compare what results were produced in using a 2 Ha case study catchment simulated in accordance with MUSIC modelling guidelines in Brisbane and in a location near Sydney and near Melbourne. The results showed that there was little difference between the three options. Overall, it was recommended that the Option 1 node was used for the simulation of the Enviro EPS 450 device. This was selected because it gave a better estimate of performance (by simulating improved performance at lower flow rates) and also because it was based on a fully independent body of data.

1. Introduction

1.1 Background

Enviro Australis have developed several products for the removal of pollutants from stormwater, including the Enviro EPS 450 450 product. In 2014, a series of tests were undertaken on the Enviro EPS 450 450 and another treatment system, the VSDU-600. Testing was managed by Enviro Australia (then Aquavest Pty Ltd and Retaw Pty Ltd) and undertaken by three organisations including:

- Ecological Consultants Australia – collected sediments, made recommendations based on test results and reviewed final reports
- SESL – An analytical laboratory who undertook soil and water sample analysis and mixed soil samples to make a required PSD and nutrient mixture
- Manly Hydraulics Laboratories (MHL) - part of the New South Wales Government Office of Environment and Heritage, MHL conducted the full scale testing procedure including setup, providing flow, dosing pollutants and sampling inflow and outflow of the units.

All testing was conducted at full scale and on an Enviro EPS 450 450 device with a nominal treatment flow capacity of 80 L/s. The Australian Flow Management Group (AFMG) at the University of South Australia was approached by Enviro Australis to develop a 'MUSIC' model node to simulate the performance of the Enviro EPS 450 450 product based on the current body of performance test results. It is understood that the MUSIC nodes are intended to be provided to and applied by design engineers for simulation of the Enviro EPS 450 450 performance in proposed urban developments.

1.2 Project Aims

To develop a node which appropriately simulates the performance of the Enviro Australia 'Enviro EPS 450 450' device with a nominal treatment capacity of 80 L/s in the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software.

2. Review of Similar Node Packages

The treatment nodes in the MUSIC modelling software package is largely limited to natural non-proprietary systems. There are however two node options which are intended to be modified by the user based on observed performance data. These nodes include the GPT node and the generic node, both of which are intended to simulate proprietary stormwater treatment products. The following review includes basic details on MUSIC performance simulation tools and data made by other manufacturers in the proprietary stormwater device market. The review was based on grey literature available online, some of which was based on following links directly from the 'Products' option in the MUSIC GPT node. Note that not all of the products in this tab provide MUSIC simulation data.

2.1 Rocla / CDS

- Rocla market CDS stormwater treatment products.
- Their online tools provide detailed instructions and MUSIC model templates for their products.
- Model templates are based on a concentration based capture efficiency.
- This capture efficiency is linear, based on a single point up to the specified product flow rate
- They recommend that TN capture is zero, but have TP removal built in.

2.2 EcoSol

- Provide instructions on how to set up a MUSIC model for their product

- Recommendations are based on a concentration based capture efficiency. (this appears to have been prepared before the flow based capture efficiency was introduced)
- Their removal includes TN and TP values

2.3 Humes (Humeceptor)

- Provide instructions and a sample MUSIC file
- Recommendations are based on a concentration based capture efficiency with NO BYPASS for some reason.
- Their removal includes both TN and TP values.

Other manufacturers, such as SPEL and Stormwater360°, offer to undertake MUSIC modelling on behalf of the client. Modelling assumptions could not be determined based on the review of inline literature, however it should be noted that the AFMG did not contact manufacturers directly for information. It is also noted that performance data for some Stormwater360° products are made available, from which such performance may be derived or, where modelling is provided, verified.

3. Development of a Node for the Enviro EPS 450 450

The node for the Enviro EPS 450 450 was developed with reference to the available performance data provided by Enviro Australis, described in Section 3.1. Appropriate nodes to represent the Enviro EPS 450 450 were then selected as described in Section 3.2. Detailed input for the three potential alternatives was then determined as described in Section 3.3. This involved the consideration of three alternative options for node data entry. To select an appropriate node from the three alternatives, three simple case studies were simulated to determine which gave the most reasonable outcome based on the known performance data. The case studies are described in Section 3.4. An appropriate node approach was selected using the methods described in Section 3.5. It should be noted that development has been undertaken using MUSIC Version 6.1.

3.1 Performance of the Enviro Australis

There were several sources of performance data provided to the AFMG on which our understanding of the performance of the Enviro EPS 450 450 product was based. The data sources are summarised below:

- Independent test reports of full scale laboratory testing by Manly Hydraulics, including:
    - Performance of the unit with fixed inflow rate (nominal flow rate of the test unit at 80 L/s) and varying inflow water quality
    - Performance of the unit with a fixed nominal inflow water quality and varying flow rates
- Spreadsheet data produced by Enviro Australis, including the test results from Manly Hydraulics and varying interpretations of the observed water quality improvement performance to produce 'normalised' system performance data.

AFMG have elected to examine the independently produced performance results from Manly Hydraulics and the normalised data for the derivation of the recommended MUSIC node. For the information of Enviro Australis, corresponding nodes have been produced which use the Enviro Australis 'normalised' data. These are made available to compare the simulation outcomes of using the raw data from Manly Hydraulics and the normalised data for three capital city design scenarios based on performance estimation using local MUSIC modelling guidelines (Section 3.4).

3.2 Node selection

There are two nodes that are suitable for the simulation of the Enviro EPS 450 450. These are the GPT node and the generic node. These two nodes are essentially identical. They are both used to simulate treatment based on user specified transfer functions. The only differences between these two nodes are:

- a generic node can be used to specify a flow reduction, an option not available for the GPT node
- The generic note is visually represented in the MUSIC model setup screen by a 'G' icon, and the GPT is represented by a litter basket icon (Figure 1). These visual representations have no effect on performance assessment.

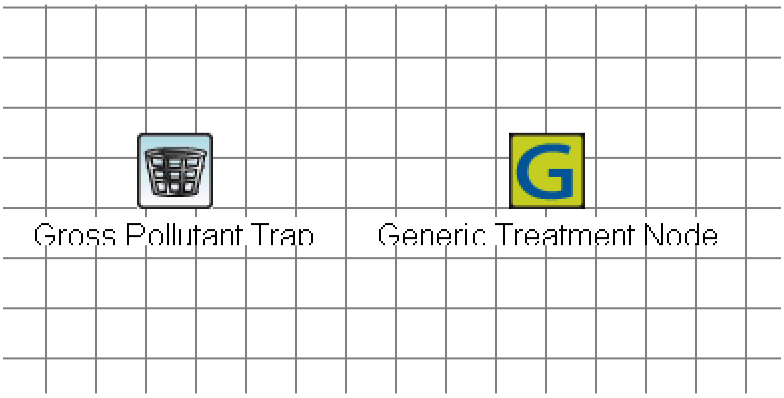


Figure 1 – Appearance of the gross pollutant trap and generic treatment nodes in the MUSIC model software

We recommend that the GPT node is used for the Enviro Australis unit. This is because it prevents the possibility for a reduced flow rate to be simulated by mistake and it is also in line with current practice by other water quality tools such as those reviewed in Section 2.

3.3 Appropriate GPT Node Input

There are three approaches for the application of water quality improvement performance using the GPT node (or generic node) in the MUSIC modelling tool. These are:

1. A transfer function which derives a pollutant outflow concentration based on pollutant inflow concentration data (i.e. the user specifies the removal efficiency of the device based on inflow pollutant concentration, and flow rate is not considered). The resulting transfer function is a fixed function for simulating treatment which applies uniformly over the designated flow rate range of the product (i.e. it applies to all flow up to the nominal treatment flow capacity, and flow in excess of this is bypassed untreated).
2. Development of a treatment function based on the inflow rate (i.e. the user specifies the removal efficiency of the device with respect to inflow rate – inflow pollutant concentration is not considered). Like the method above, this function also applies within a designated flow rate range, an inflow rates above the maximum or below the minimum are bypassed untreated. Note that this capability is only available in MUSIC Version 6.
3. Development of a treatment function that considers both flow rate and inflow concentration. This will apply up to the nominated flow capacity. Note that this capability is only available in MUSIC Version 6.

Based on the data available, AFMG have chosen to adopt a function based on the first approach (pollutant concentration based, as Option 3 in this report) and the second approach (device inflow rate based, as Options 1 and 2 in this report). The three alternatives are described in the following sections. Selections were made in recognition of the influence of flow rate on the performance of the Enviro EPS 450 450. AFMG understand that future testing of the product is planned and this may allow for flow and concentration based performance modelling to be undertaken, or for refinement of the existing treatment tools.

3.3.1 Option 1 – Flow Based Capture Efficiency, Performance Date As Reported

As part of their reporting of test results, Manly hydraulics provided Enviro Australis with performance data which was derived using estimated removal rates with an averaged influent approach. The benefits of adopting this data is that this information was developed in a manner fully independent of Enviro Australis. This data was provided to the AFMG as plots in a report, and the derivation of suitable figures has been conducted using a plot digitising tool.[1] Note that 100% removal of gross pollutants was assumed based on the results of reporting by Manly Hydraulics Laboratories[2].

Total Suspended Solids

Averaged removal rate data for TSS was provided as shown in Table 1. Corresponding data input for the treatment of TSS in MUSIC via node Option 1 is presented in Figure 2.

Table 1 - Table of raw data for treatment of TSS with respect to flow rate

Flow rate (L/s)	**Nominal concentration (mg/L)**	**Capture efficiency (%)**
20	94.9	94.9
40	89.5	89.5
60	78.9	78.9
80	72.6	72.6
100	69.3	69.3

[1] 150609 Retaw SDU-2 Report_Final V3.pdf and 150610 Retaw_SDU&VSDU20150610.pdf
[2] 150609 Retaw SDU-2 Report_Final V3.pdf and 150610 Retaw_SDU&VSDU20150610.pdf

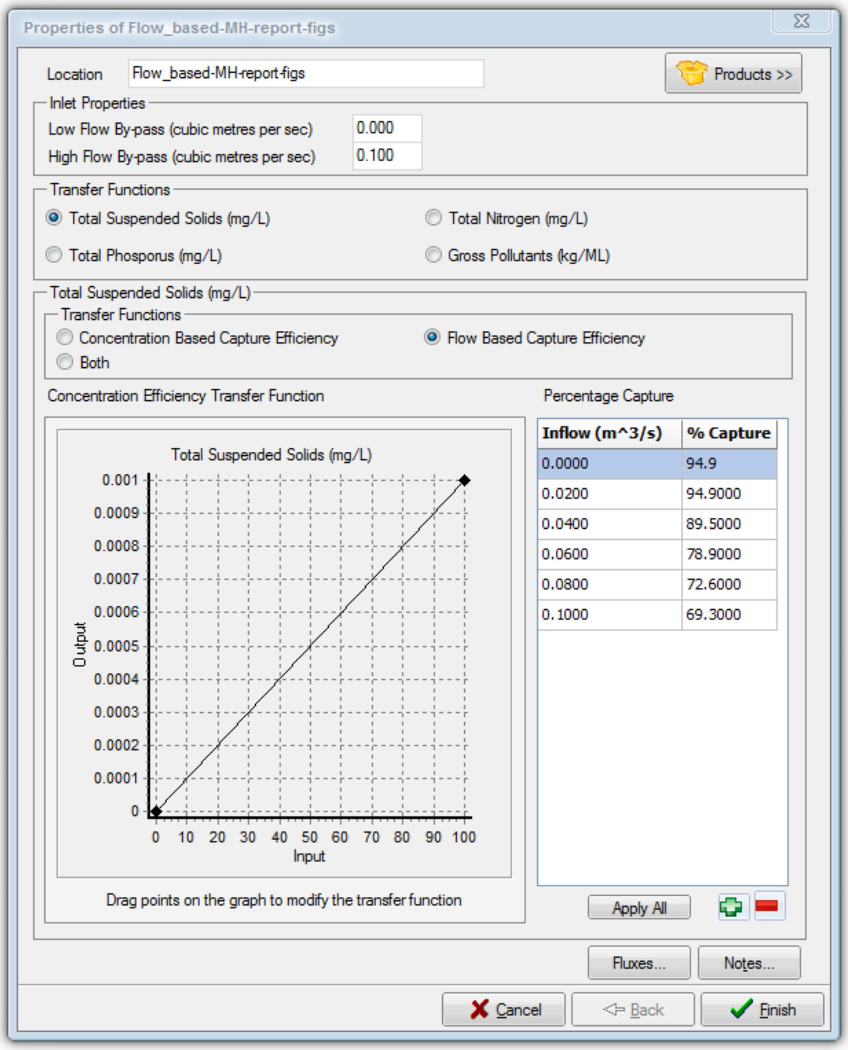


Figure 2 – Screen shot of data input to represent device performance for TSS using the raw data in the GPT node

Total Phosphorous

Averaged removal rate data for TP was provided as shown in Table 2. Corresponding data input for the treatment of TP in MUSIC via node Option 1 is presented in Figure 3.

Table 2 - Table of raw data for treatment of TP with respect to flow rate

Flow rate (L/s)	**Nominal concentration (mg/L)**	**Capture efficiency (%)**
20	0.452	100.0
40	0.452	56.1
60	0.452	74.1
100	0.452	68.0

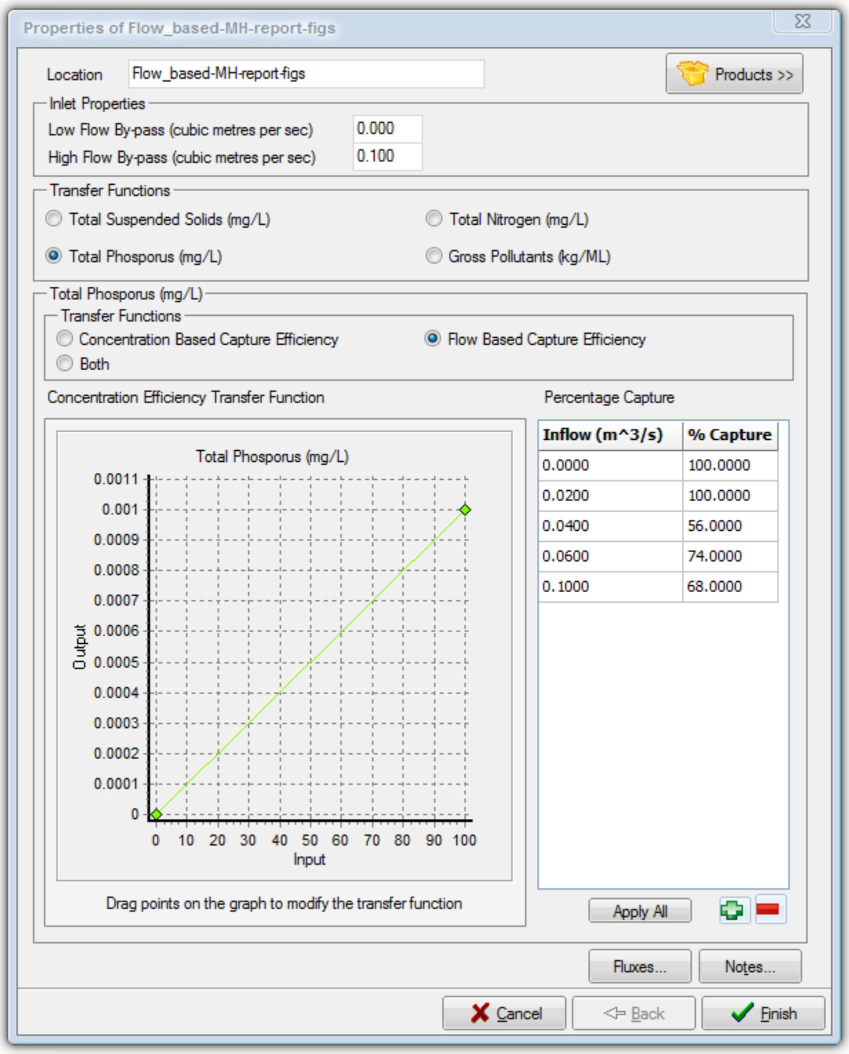


Figure 3 – Screen shot of data input to represent device performance for TP using the raw data in the GPT node

Total Nitrogen

Averaged removal rate data for TN was provided as shown in Table 3. Corresponding data input for the treatment of TN via node Option 1 in MUSIC is presented in Figure 4.

Table 3 - Table of raw data for treatment of TN with respect to flow rate

Flow rate (L/s)	Nominal concentration (mg/L)	Capture efficiency (%)
20	1.54	66.7
40	1.54	14.4
60	1.54	45.3
100	1.54	48.6

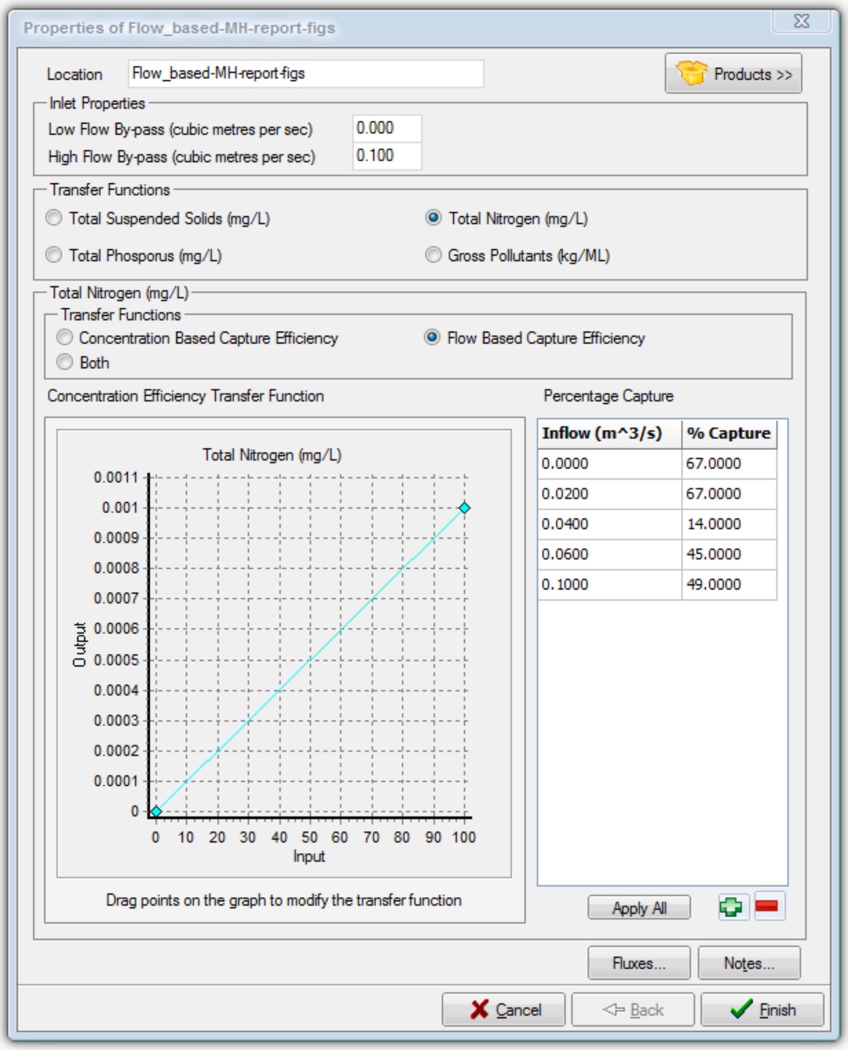


Figure 4 – Screen shot of data input to represent device performance for TN using the raw data in the GPT node

3.3.2 Option 2 – Flow Based capture Efficiency, Performance Data Normalised

Among the results provided to the AFMG, 'normalised' performance data was provided. AFMG understand that this normalisation procedure has been performed by Enviro Australis, and the process was agreed to by independent bodies involved in the testing including Manly Hydraulics Laboratories and Ecological Consultants Australia. Normalised data for pollutant removal was provided as both a spreadsheet of results and in the form of a report[3]. Note that 100% removal of gross pollutants was assumed for Option 2 based on the results of reporting by Manly Hydraulics[4].

Total Suspended Solids

The normalised data for TSS is shown in Table 4. Corresponding data input for the treatment of TSS in MUSIC via node Option 2 is presented in Figure 5.

Table 4 - Table of normalised data for treatment of TSS with respect to flow rate

Flow rate (L/s)	Nominal concentration (mg/L)	Normalised capture efficiency (%)

[3] 150302 Retaw SDU & VSDU test results.pdf
[4] 150609 Retaw SDU-2 Report_Final V3.pdf and 150610 Retaw_SDU&VSDU20150610.pdf

20	250	97.3
40	250	94.4
60	250	92.8
80	250	90.8
100	250	88.4

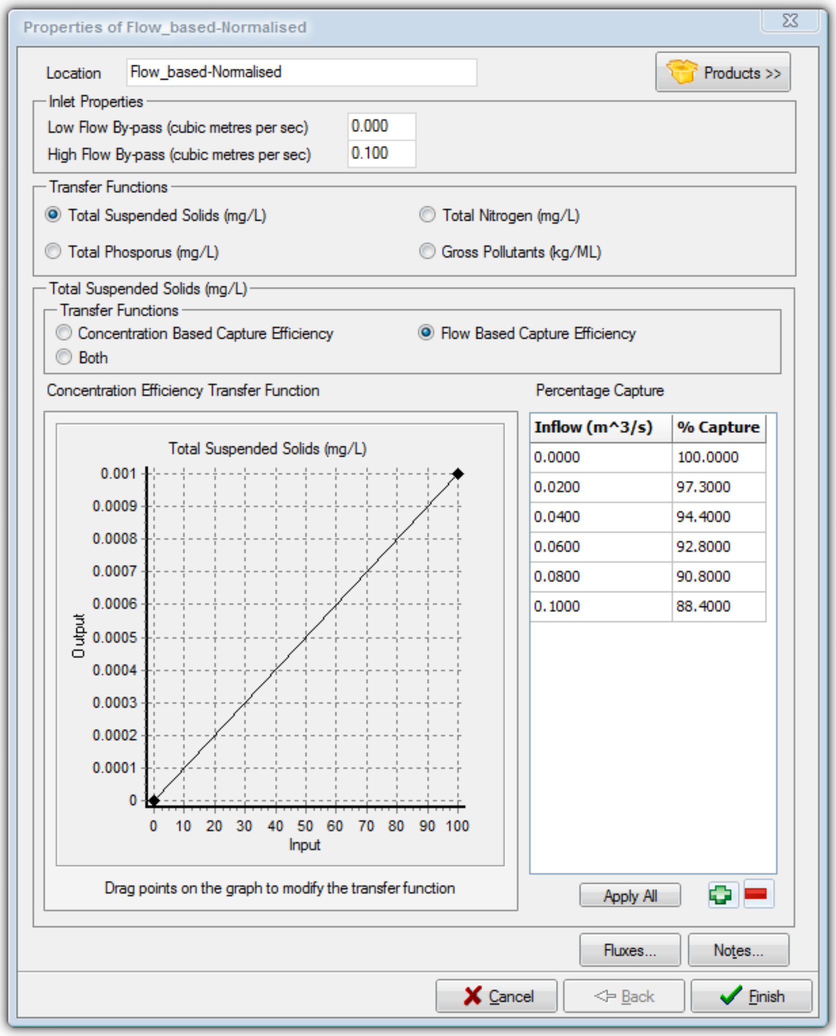


Figure 5 – Screen shot of data input to represent device performance for TSS using the normalised data in the GPT node

Total Phosphorus

The normalised data for TP is shown in Table 5. A screenshot of corresponding data input for the treatment of TP in MUSIC via node Option 2 is presented in Figure 6.

Table 5 - Table of normalised data for treatment of TP with respect to flow rate

Flow rate (L/s)	Nominal concentration (mg/L)	Normalised capture efficiency (%)
20	0.452	88.9
40	0.452	80.1
60	0.452	80.1
80	0.452	88.9
100	0.452	75.7

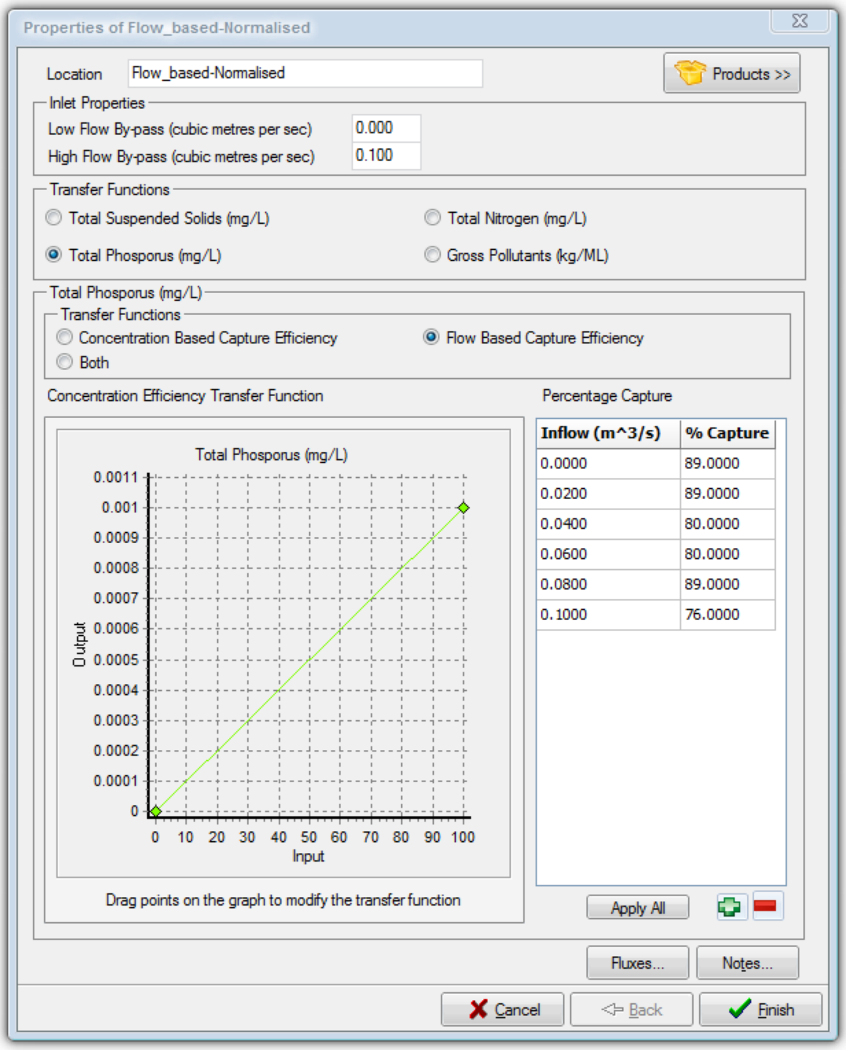


Figure 6 - Screen shot of data input to represent device performance for TP using the normalised data in the GPT node

Total Nitrogen

The normalised data for TN is shown in Table 6. A screenshot of corresponding data input for the treatment of TN in MUSIC via node Option 2 is presented in Figure 7.

Table 6 - Table of normalised data for treatment of TN with respect to flow rate

Flow rate (L/s)	Nominal concentration (mg/L)	Normalised capture efficiency (%)
20	1.54	78.6
40	1.54	63.1
60	1.54	58.5
80	1.54	67.0
100	1.54	61.8

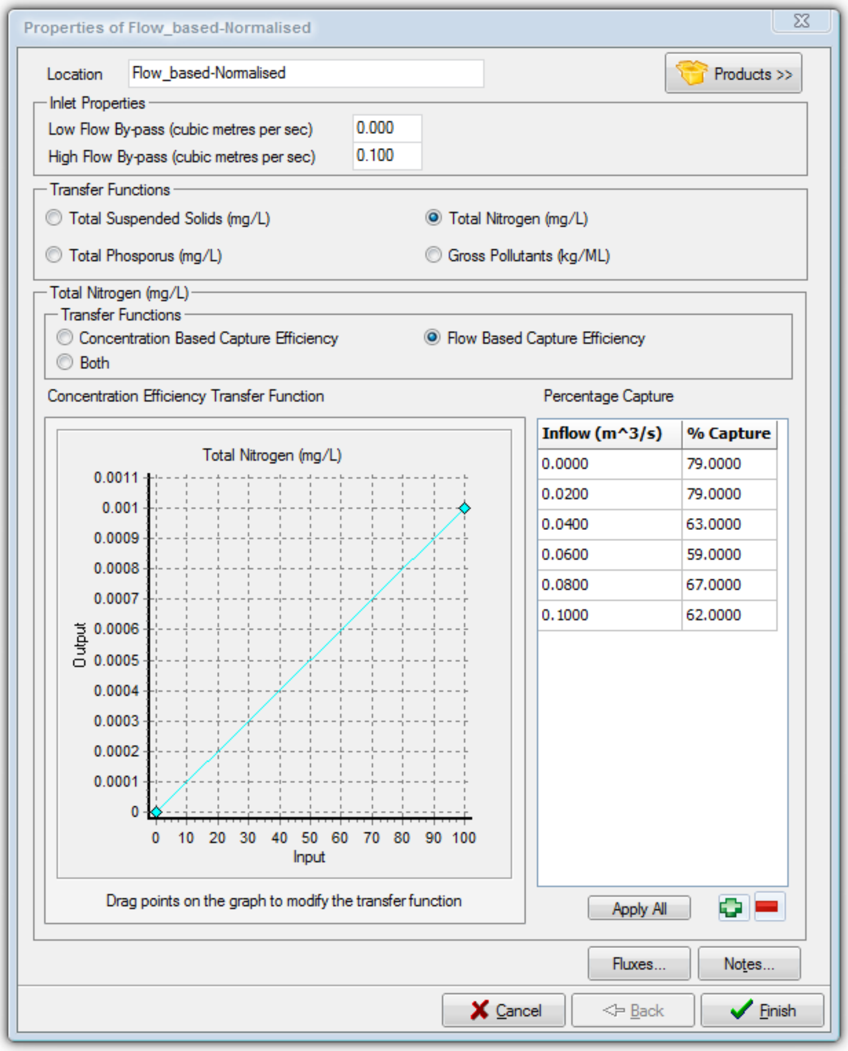


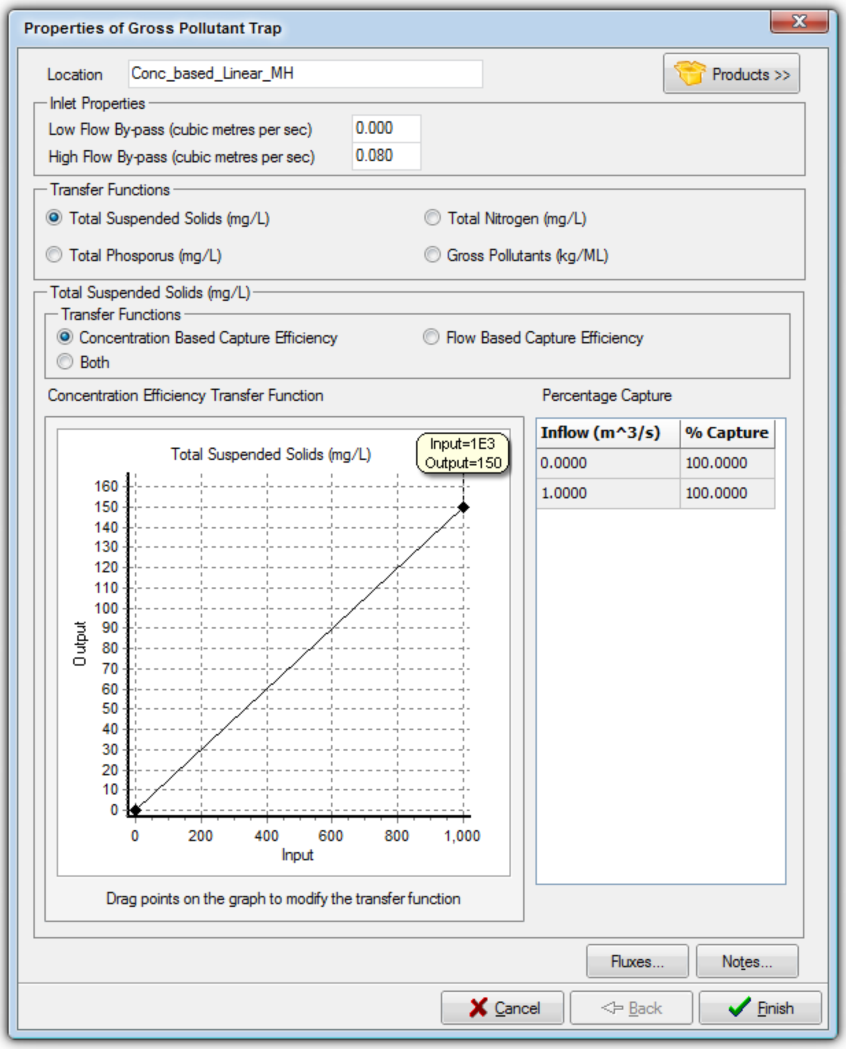
Figure 7 – Screen shot of data input to represent device performance for TN using the normalised data in the GPT node

3.3.3 Option 3 – The use of a single value, concentration based transfer function

Based on a review of freely obtainable MUSIC node templates and MUSIC modelling instructions by stormwater treatment device manufacturers (e.g. Humes, Rocla and EcoSol) the use of a linear, single point, inflow pollutant concentration based transfer function is a common practice for estimating the performance of stormwater improvement devices. This may be because the option to use flow based pollutant concentration efficiencies is relatively new, as it only became available in MUSIC Version 6, released late 2013. For consistency, we have elected to derive a MUSIC performance estimation node for using a single point, linear, inflow pollutant concentration based transfer function using the Enviro EPS 450 450 device. The single point concentration is derived from the overall performance of the unit at a nominal flow rate which was independently estimated by Manly Hydraulics[5]. Note that 100% removal of gross pollutants was assumed based on the results of reporting by Manly Hydraulics[6].

Total Suspended Solids

The removal rate data for TSS was noted to be 85% using sediment with a particle size distribution considered representative of Australian stormwater runoff. A screenshot of the corresponding data input for the treatment of TSS in MUSIC via node Option 3 is presented in Figure 8.



[5] 150609 Retaw SDU-2 Report_Final V3.pdf and 150610 Retaw_SDU&VSDU20150610.pdf
[6] 150609 Retaw SDU-2 Report_Final V3.pdf and 150610 Retaw_SDU&VSDU20150610.pdf

Figure 8 – Screen shot of data input to represent device performance for TSS using the single value, concentration based transfer function in the GPT node

Total Phosphorous

The removal rate data for TP was noted to be 75% based on a concentration considered representative of Australian stormwater runoff. A screenshot of corresponding data input for the treatment of TSS in MUSIC via node Option 3 is presented in Figure 9. It should be noted that some uncertainty around the nutrient removal performance was noted by Manly Hydraulics.

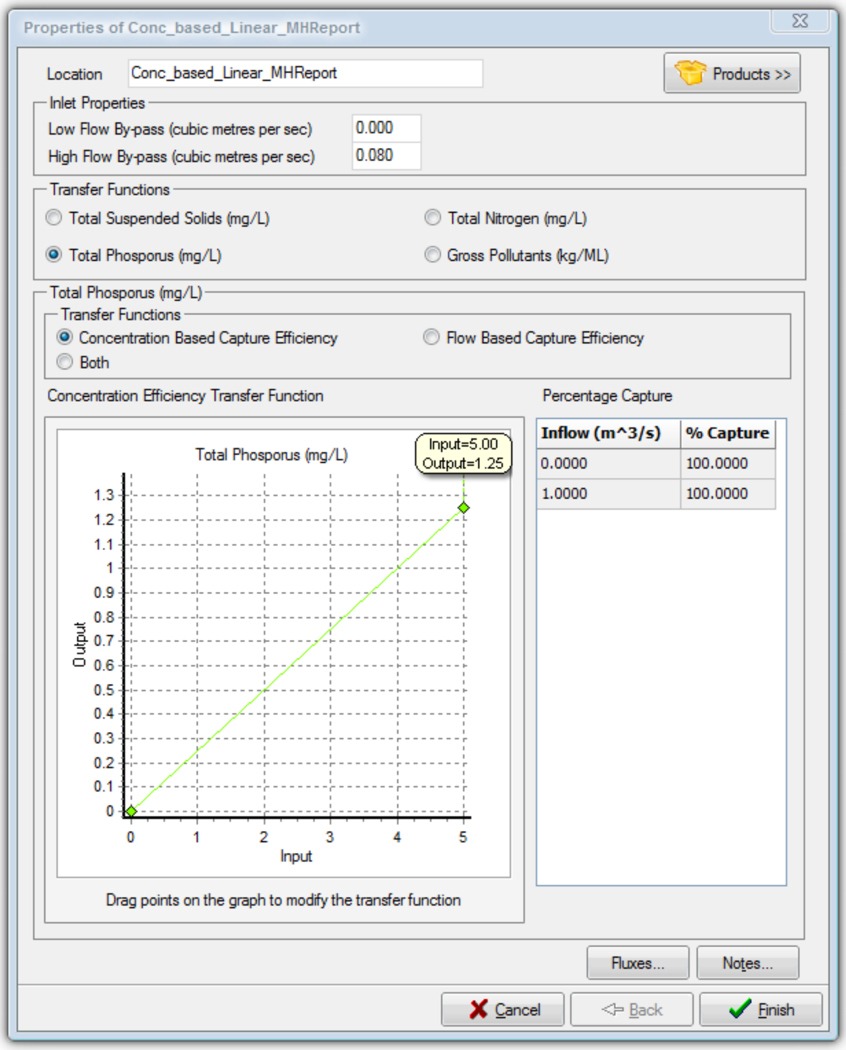


Figure 9 – Screen shot of data input to represent device performance for TP using the single value, concentration based transfer function in the GPT node

Total Nitrogen

The removal rate data for TN was noted to be 45% based on a concentration considered representative of Australian stormwater runoff. A screenshot of corresponding data input for the treatment of TSS in MUSIC via node Option 3 is presented in Figure 10. It should be noted that some uncertainty around the nutrient removal performance was noted by Manly Hydraulics.

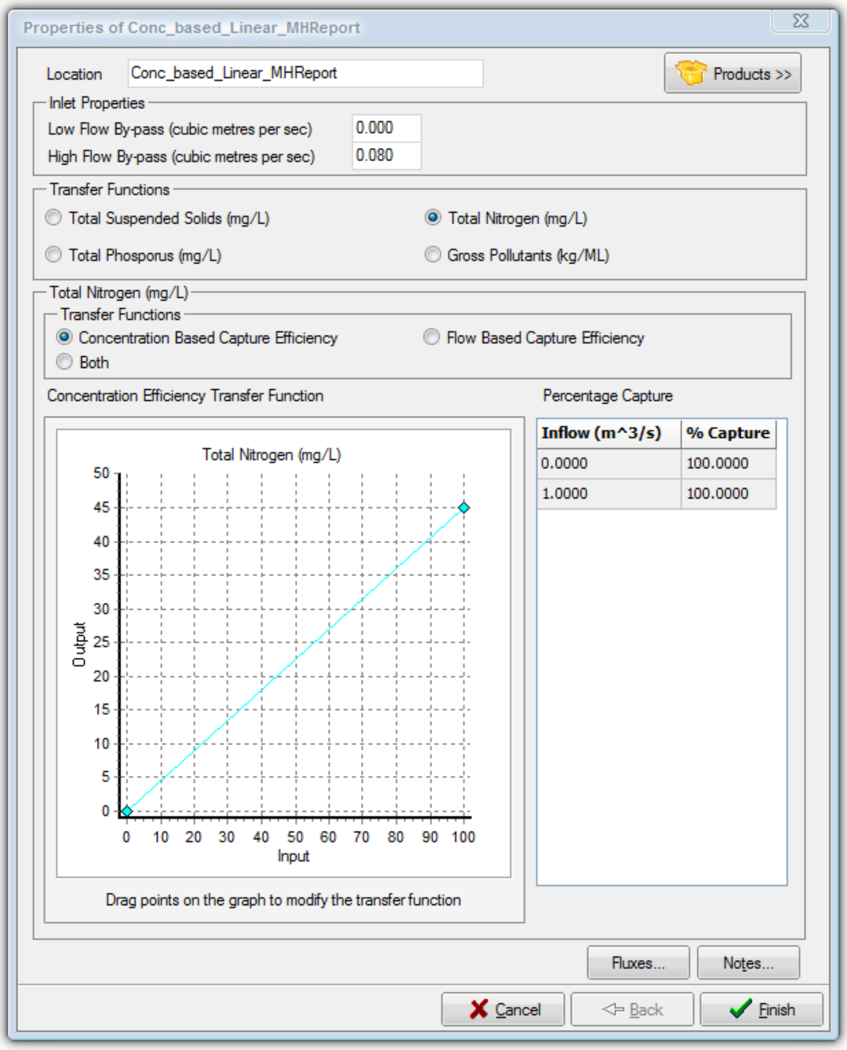


Figure 10 – Screen shot of data input to represent device performance for TN using the single value, concentration based transfer function in the GPT node

3.4 Case Study Description

A case study was developed to compare the performance of the three Enviro EPS 450 450 performance node options described in Section 3.3 in a simple 'real world' scenario. For this purpose, a conceptual case study site was produced based on the application of an Enviro EPS 450 unit with a nominal capacity of 100 L/s to a 2 Ha fully urbanised residential catchment of medium density which drains to a single point where the Enviro EPS 450 450 is situated[7]. The scenario was then simulated in the MUSIC model for three locations using local MUSIC modelling guidelines including Sydney (BMT WBM, 2010)[8], Brisbane (Water by Design, 2010) and Melbourne (Melbourne Water, 2010). Note that more recent guidelines are available in the case of Sydney, but these are specific to the drinking water catchment area an not the Sydney basin (Sydney Catchment Authority, 2012). In all cases, the catchment was simulated in a lumped manner assuming no treatment systems at the allotment nor in any public space. This was considered a conservative measure for the Enviro EPS 450 450, where in reality rainwater tanks of at least 1 kL would typically be present on each allotment in most cases. A summary of runoff and pollutant generation node input data for

[7] Note that the Enviro EPS 450 450 has a nominal capacity of 80 L/s but performance data was made available showing treatment up to 100 L/s

the three scenarios is presented in Table 7. The following key assumptions were made in data selection:

- The medium development density was approximately 40 dwellings per hectare. Since no guidance was provided for this parameter for the Sydney guidelines (which require analysis of aerial photography or specific site plans) the 65% imperviousness value for the Brisbane case study was used.
- The selection of pervious area parameters in the Sydney case study were based on the assumption of a sandy loam material at the development site. Note that both Melbourne and Brisbane guidelines give specific data for soil assumptions regardless of soil type.

Table 7 –Summary of catchment source node parameters for the 2 Ha residential case study catchment

Parameter	**Brisbane Case Study[1]**	**Sydney Case Study[2]**	**Melbourne Case Study[3]**
Location	Brisbane city	Katoomba	Koo Wee Rup
Rain gauge	Brisbane airport	Katoomba	Koo Wee Rup
Catchment area (Ha)	2	2	2
Impervious area (%)	65	65	75
Rainfall threshold (mm)	1	1	1
Soil store capacity (mm)	500	195	30
Initial storage (%)	10	10	25
Field capacity (mm)	200	135	20
Infiltration Coefficient ‘a’	211	250	200
Infiltration Coefficient ‘b’	5	1.3	1
Initial depth (mm)	50	50	10
Daily recharge rate (%)	28	60	25
Daily baseflow rate (%)	27	45	5
Daily deep seepage rate (%)	0	0	0
TSS – Baseflow – Mean (log mg/L)	1	1.2	1.1
TSS – Baseflow – St dev (log mg/L)	0.34	0.17	0.17
TSS – Stormflow – Mean (log mg/L)	2.18	2.15	2.2
TSS – Stormflow – St dev (log mg/L)	0.39	0.32	0.32
TP – Baseflow – Mean (log mg/L)	-0.97	-0.85	-0.82
TP – Baseflow – St dev (log mg/L)	0.31	0.19	0.19
TP – Stormflow – Mean (log mg/L)	-0.47	-0.6	-0.45
TP – Stormflow – St dev (log mg/L)	0.32	0.25	0.25
TN – Baseflow – Mean (log mg/L)	0.2	0.11	0.32
TN – Baseflow – St dev (log mg/L)	0.2	0.12	0.12
TN – Stormflow – Mean (log mg/L)	0.26	0.3	0.42
TN – Stormflow – St dev (log mg/L)	0.23	0.19	0.19
[1] – Parameters were selected from Water by Design (2010). [2] – Parameters were selected from Sydney Catchment Authority (2012). [3] – Parameters were selected from Melbourne Water (2010).			

3.5 Selection of an Appropriate Node

Following the simulation of the three case studies, data was plotted for visual comparison. Selection of an appropriate node was undertaken using a qualitative assessment of the data from each option in the three case studies. The assessment was based on factors including:

1. The simulation of the performance presented in the three case studies with respect to other similar treatment nodes for commercial device
2. The independence of data used as treatment node input

4. Node Option - Performance Assessment

An assessment of the performance of Enviro EPS 450 450 performance node Options 1, 2 and 3 was conducted using the methods described in Section 3.4. The results for the Brisbane case study are presented in Section 4.1. The results for the Sydney case study are presented in Section 4.2 and the outcomes in Melbourne are presented in Section 4.3.

4.1 Brisbane (City)

The 'Brisbane' case was 2 Ha residential catchment of approximately 40 dwellings per hectare located in Brisbane city, using rainfall and PET data from Brisbane Airport. The development was simulated as a lumped node and in accordance with input data recommended by Water by Design (2010). Figure 11 shows the comparative performance of Enviro EPS 450 performance node Options 1, 2 and 3 in response to this scenario.

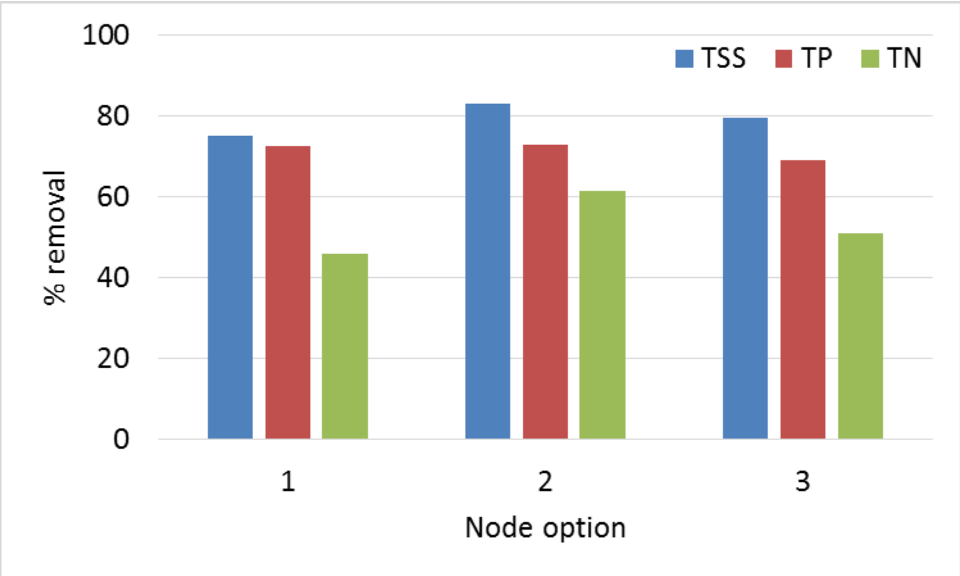


Figure 11 – Comparison of the simulated performance of the Enviro EPS 450 using treatment node Options 1, 2 or 3 for a 2 Ha residential catchment in Brisbane

4.2 Sydney (Blue Mountains)

The 'Sydney' case was 2 Ha residential catchment of approximately 40 dwellings per hectare located west of Sydney in the Blue Mountains of NSW, using rainfall and PET data from Katoomba. The development was simulated as a lumped node and in accordance with input data recommended by BMT WBM (2010) and assuming a sandy loam soil at the development site[9]. Figure 12 shows the comparative performance of Enviro EPS 450 treatment node Options 1, 2 and 3 in response to this scenario.

[9] The guidelines for NSW do not allow generic development density data for a catchment of 2 Ha, it should be calculated based on site plans. As such, the value for Brisbane was used (65% imperviousness). There are also no generic soil values recommended by NSW, and properties must be based on soil type. For this reason, sandy loam was assumed.

Figure 12 – Comparison of the simulated performance of the Enviro EPS 450 using treatment node Options 1, 2 or 3 for a 2 Ha residential catchment in the Blue Mountains near Sydney, NSW.

4.3 Melbourne (Koo Wee Rup)

The 'Melbourne' case was 2 Ha residential catchment of approximately 40 dwellings per hectare located in Koo Wee Rup south west of Melbourne, using rainfall and PET data from Koo Wee Rup. The development was simulated as a lumped node and in accordance with input data recommended by (Melbourne Water, 2010) for a medium density development (75% impervious in this case). Figure 13 shows the comparative performance of Option 1, 2 and 3 in response to this scenario.

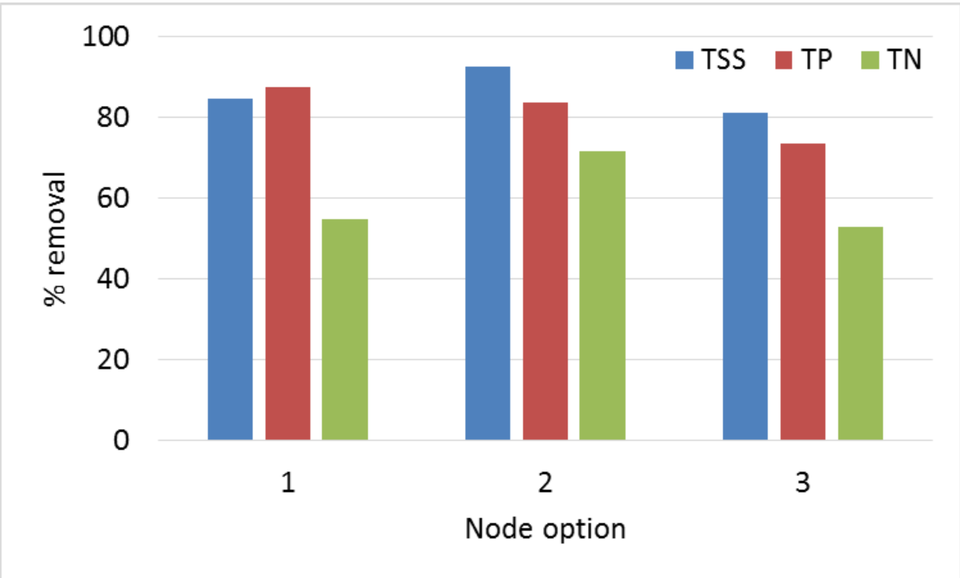


Figure 13 – Comparison of the simulated performance of the Enviro EPS 450 using treatment node Options 1, 2 or 3 for a 2 Ha residential catchment in Koo Wee Rup, south west of Melbourne, VIC.

5. Discussion of Results

5.1 Treatment Node

The results indicate that the relative performance of the three options are similar regardless of location. Option 1 and 2 provide a relatively similar performance estimate, but Option 3 is slightly lower than Option 1 and 2. Based on the outcomes of this analysis, it is recommended that Option 1 is used for the simulation of the Enviro EPS 450 device. This is because the data generated can be observed by all parties as fully independent of the manufacturer (Enviro Australis) and does not overestimate nor underestimate the performance based on current test results.

A version of the Enviro EPS 450 nodes suitable for Options 1, 2 and 3 has been provided to Enviro Australis. Notes on the nodes provided and how they are used are provided in Appendix A. These consist of treatment nodes with instructions as a background image. The file names may be changed without impact on the performance of the nodes enclosed. Note that once the MUSIC file is opened, these nodes may be copied and pasted into any other MUSIC model file as instructed in Appendix A.

5.2 Nutrient Capture Performance

Enviro Australis may consider specifying lower treatment for total nitrogen. Testing undertaken at Manly Hydraulics was based the derivation of nutrients from a soil/compost mix which was provided by SESL. AFMG were provided with data for TN, NO_3 and NH_4. A review of this data suggests that a significant portion of the nitrogen may have been present in organic form. While removal of TN was observed in the results of independent testing, the removal of organic nitrogen is not considered typical of field conditions; reviews of stormwater quality indicate that nitrogen is typically present in a dissolved form in stormwater due to the presence of oxygen in overland flow (Duncan, 1999, Duncan, 2005). As such, nitrogen in flowing stormwater is unlikely to be removed in significant levels by filtration or short term storage. On this basis, any claim regarding the removal of nitrogen by a stormwater treatment device should be made and received with caution. We note that similar products tend to have much lower recommendations for nitrogen removal:

- Ecosol recommend 45% for the Ecosol GPT
- Humes recommend 30% TN removal for the Humeceptor
- Rocla recommend between 0 and 79% removal for their product range

5.3 Node Recommendation for Early Versions of the MUSIC Software

Enviro Australis may also consider providing the Enviro EPS 450 node Option 3 to prospective clients who may be using earlier versions of the MUSIC model for performance estimation. MUSIC model Version 6 and later are based on an online licence which requires an annual fee. It is possible that some design engineers use earlier versions of MUSIC which were able to be purchased outright to avoid paying an annual fee. The use of earlier versions of MUSIC may or may not be acceptable in some jurisdictions, but Enviro Australis may consider providing the Option 3 node on request where it is, noting that results will be a conservative underestimate based on the test data provided.

5.4 Enviro EPS 450 Capacity

To date, all testing has been conducted using an Enviro EPS 450 device with a nominal capacity of 80 L/s. It is recommended that Enviro EPS 450 systems with higher or lower capacity be examined to determine whether the performance data currently available is linearly or otherwise related to the performance of the 80 L/s system.

5.5 Further Research Directions

Enviro Australis have already undergone significant product testing to ensure that their product provides a high level of treatment at nominal flow capacity, and better treatment at flow rates below capacity. It is noted that the expense of full scale performance testing can be prohibitive, both in the laboratory and in field. It is however suggested that ongoing monitoring be undertaken using the Enviro EPS 450 device to verify the performance currently indicated by full scale laboratory studies. Performance data from field installations would be a valuable addition to the performance data. A focus on repeated performance for removal of target contaminants at a range of flow rates for larger and smaller devices is also considered valuable to provide confidence in the assumption that treatment performance is linearly related to the nominal treatment flow capacity. For the purposes of MUSIC performance simulation, the analysis of gross pollutants, TSS, TN and TP are adequate, but it is recommended that the simulation performance of MUSIC be monitored by Enviro Australis in case other parameters are presented in MUSIC by default. Other parameters may currently be simulated, but it is in a 'workaround' form that requires research and data entry entirely up to the modeller and not a common practice. Finally, the removal of nutrients, particularly nitrogen in different forms should be investigated to ensure that the assumed removal is typical of that considered for stormwater.

6. Conclusion

Based on the study findings, is it recommended that the Enviro EPS 450 node Option 1 be used for the simulation of the Enviro EPS 450 device. This node is selected because it provides a better estimate of performance (by simulating an improved performance at lower flow rates, unlike Option 3) and also because it was based on a fully independent body of data (unlike Option 2).

7. References

BMT WBM 2010. Draft NSW MUSIC Modelling Guidelines. Sydney, NSW, Australia: Sydney Metropolitan Catchment Management Authority.

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MELBOURNE WATER 2010. MUSIC guidelines - Recommended input parameters and modelling approaches for MUSIC users. Melbourne, Victoria, Australia: Melbourne Water.

SYDNEY CATCHMENT AUTHORITY 2012. Using MUSIC in Sydney's Drinking Water Catchment. Penrith, NSW, Australia: Sydney Catchment Authority.

WATER BY DESIGN 2010. *MUSIC modelling guidelines,* Brisbane, Queensland, Australia, South East Queensland Healthy Waterways Partnership (SEQHWP).

Appendix A – Provision and Use of MUSIC node files

The MUSIC tool stores model input data as a file with the extension '.sqz'. Enviro Australis has been provided with a MUSIC .sqz for each option presented in this report. Simple instructions for the MUSIC user are provided in the background of each option. These instructions are shown below.

<u>MUSIC Instructions – Node Background data</u>

This node has been produced to simulate the performance of the Enviro EPS 450 stormwater runoff treatment device. The performance characteristics are based on testing conducted by Enviro Australis in collaboration with Manly Hydraulics Laboratories, SESL Australia and Ecological Consultants Australia.

This node template has rainfall and PET data at six minute intervals for Adelaide 1/1/1970 to 31/12/1970.

To use this node to simulate performance with other rainfall data:

1. Start a new MUSIC file and select a rainfall/PET suitable for the simulated location.
2. When you are ready to place the Enviro EPS product, select the Enviro EPS product node at left and copy this node from here and into your new catchment model. You can use 'Ctrl+C' to copy and 'Ctrl+v' to paste, or select 'copy' and 'paste' from the edit section of the 'Create model' tab above.

<u>Notes for Each Node and Node Screenshots</u>

Option 1

By clicking on the node notes (or hovering for some time over the icon) the following notes are provided with node Option 1:

> *"Performance data based on estimated capture efficiency information derived from full scale testing conducted by Enviro Australis, Manly Hydraulics Laboratories, SESL Australia and Ecological Consultants Australia. Testing was conducted at a range of flow rates.*
>
> *Node simulates capture efficiency by considering inflow rate (up to high flow bypass), but is independent of pollutant concentration."*

A screenshot of node Option 1 is provided in Figure A 1. It is designated node v1a in the MUSIC layout.

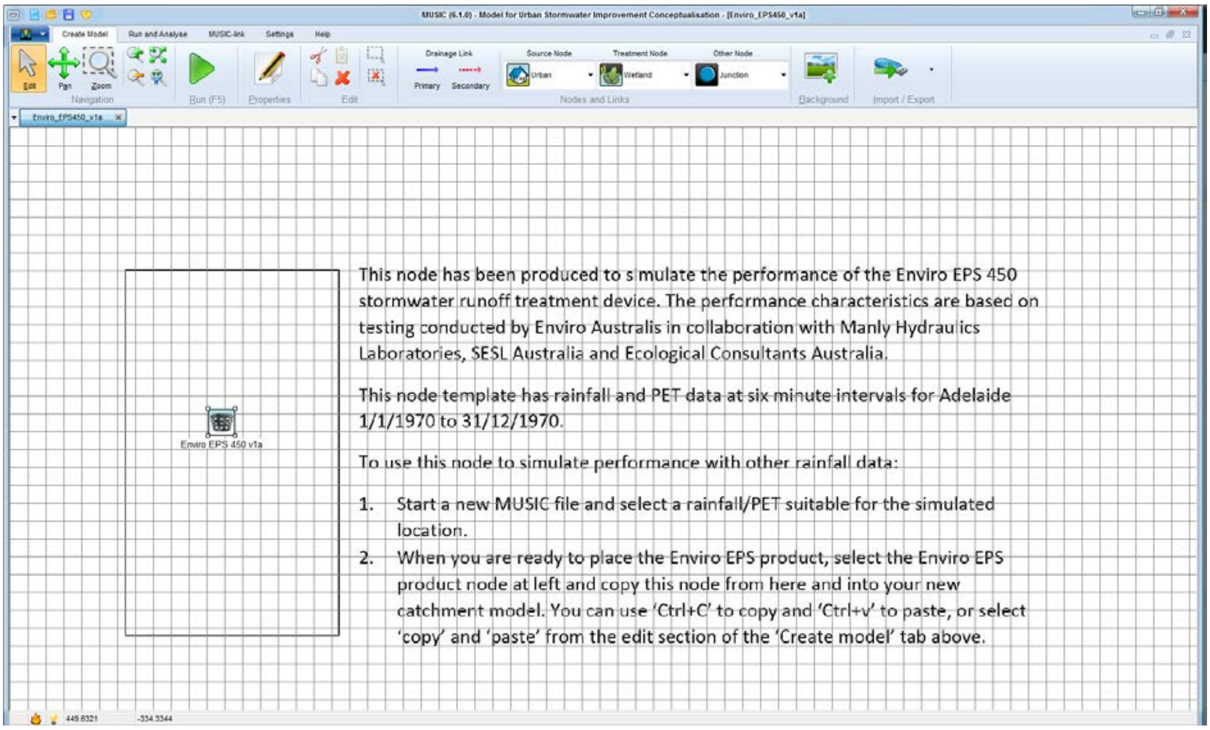

Figure A 1 – Screenshot image of node Option 1 layout

Option 2

By clicking on the node notes (or hovering for some time over the icon) the following notes are provided with node Option 2:

> *"Performance data based on estimated capture efficiency information derived from full scale testing conducted by Enviro Australis, Manly Hydraulics Laboratories, SESL Australia and Ecological Consultants Australia. Testing was conducted at a range of flow rates. Pollutant capture data was normalised using a procedure by Enviro Australis.*
>
> *Node simulates capture efficiency by considering inflow rate (up to high flow bypass), but is independent of pollutant concentration."*

A screenshot of node Option 2 is provided in Figure A 2. It is designated node v1b in the MUSIC layout.

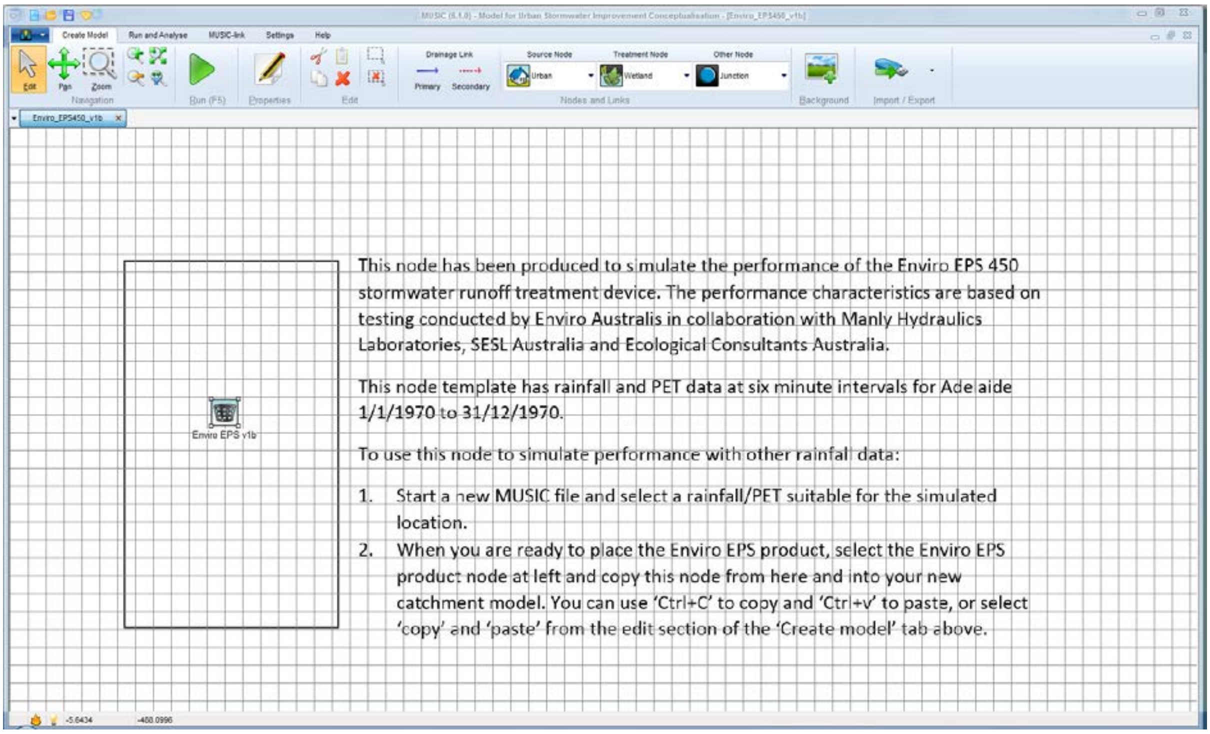

Figure A 2 – Screenshot image of node Option 2 layout

Option 3

By clicking on the node notes (or hovering for some time over the icon) the following notes are provided with node Option 3:

> *"Performance data based on estimated capture efficiency information derived from full scale testing conducted by Enviro Australis, Manly Hydraulics Laboratories, SESL Australia and Ecological Consultants Australia. Testing was conducted at a range of flow rates.*
>
> *Node simulates capture efficiency independently of inflow rate (up to high flow bypass) or inflow pollutant concentration."*

A screenshot of node Option 3 is provided in Figure A 3. It is designated node v1c in the MUSIC layout.

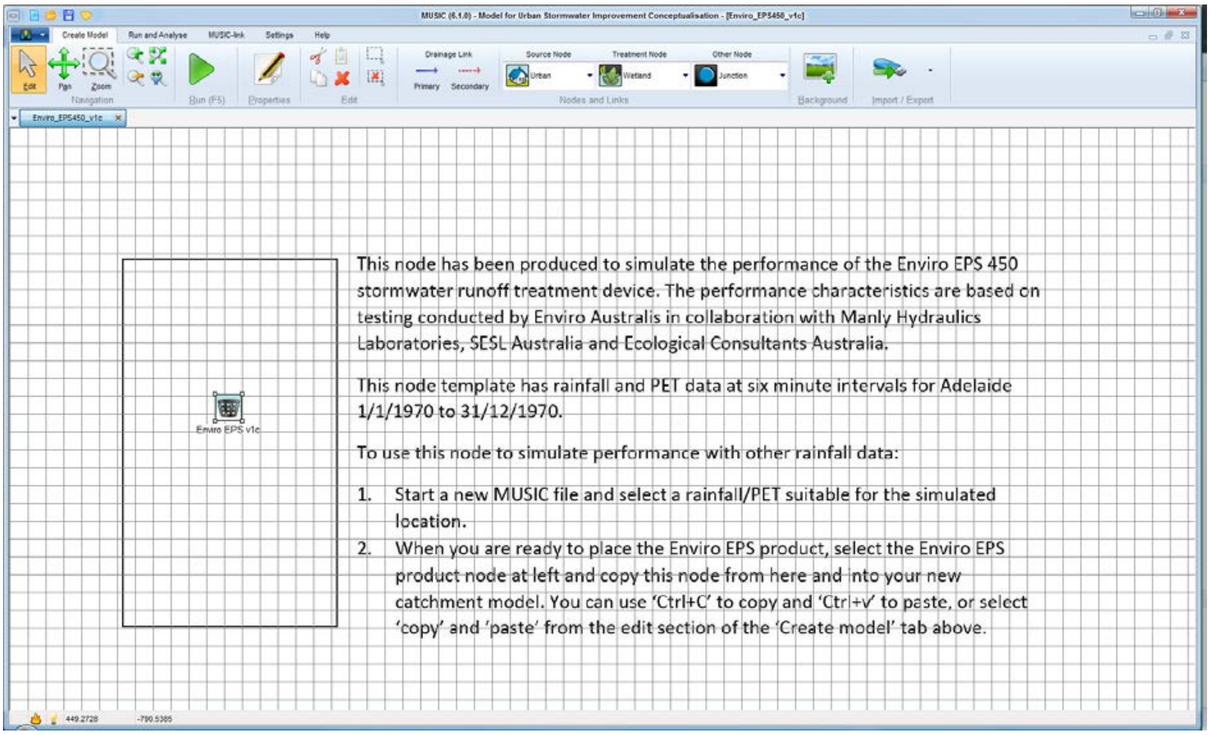

Figure A 3 – Screenshot image of node Option 3 layout