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6th August 2019

Stormwater Australia
Email: Megh.Thakkar@gmail.com

Attention: Megh Thakar

Dear Megh,

RE: STORMWATER QUALITY IMPROVEMENT DEVICE EVALUATION PROTOCOL

Ocean Protect is committed to protecting the health of our oceans and waterways and subsequently fully supports a national protocol.

As you may be aware, Stormwater Australia recently released their National Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP), which aims to provide a uniform set of criteria against which stormwater quality improvement devices (SQIDs) can be field-tested and their treatment performance reported.

Ocean Protect supports a national framework for evaluating stormwater treatment measures. However, we believe that SQIDEP (in its current form) has significant deficiencies which, if allowed to remain without amendment, will produce exaggerated or over-estimated treatment performance results for SQIDs – and, ultimately, reduced 'actual' protection of the health of our waterways.

The key objectives of this correspondence are to:

- provide some background to SQIDEP and the involvement of Ocean Protect to date;
- identify recommended changes for SQIDEP (and explain the rationale for these recommended changes);
- identify questions that we believe should be asked of Stormwater Australia executives in relation to its development, implementation and oversight of SQIDEP; and
- Outline actions that we would like your organisation to consider in relation to SQIDEP.

Background

The development of SQIDEP was initiated over six (6) years ago by Stormwater Australia, Ocean Protect and some other SQID manufacturers. Stormwater Australia has issued several versions of their SQIDEP, and the latest version (Version 1.3) is available on the Stormwater Australia website[1].

[1] https://www.stormwater.asn.au/sqidep

Ocean Protect staff members had been involved in, and support, the development of SQIDEP for the betterment of the industry, with the aim of removing misleading and unfounded claims by manufacturers and reducing undue pressure on local government authorities in meeting water quality design objectives. Whilst the SQIDEP is not perfect, it is certainly a step in the right direction for solving these problems within the industry.

Unfortunately, we consider that Ocean Protect's endeavours to amalgamate policy and promote best practice have been met with resistance, ranging from outright refusal and dissemination of misinformation, to, in some cases, what Ocean Protect considers to be an attack on the reputation of its brand.

Commercially, all manufacturers stand to gain from having a national framework for evaluating technologies. The larger players in the market, including Ocean Protect, that have been field testing for quite some time, stand to gain a commercial advantage in seeing SQIDEP being endorsed in its current form. Ethically, however, we understand that this may not be the best outcome for the environment. Consequently, we have chosen to outline the facts of the situation and provide you with information to assist you to make an informed decision on your organisation's support or otherwise of SQIDEP, and any associated evaluation.

Recommended changes to SQIDEP

There are several issues that currently exist with the current SQIDEP and evaluation framework that we feel need to be modified. Several technical modifications should be made to the protocol, not to make compliance more difficult, but to close existing loopholes, stop potential "gaming" of the system in the form of overestimated performance claims, and consolidating relevant standards. The modifications that we would suggest are:

- Change the number of qualifying storms (for single and multiple sites) from 15 to 12, but introduce a requirement for sequential complying storms:
    - We consider this is essential to avoid manufacturers 'cherry picking' data. For example, SQIDEP (in its current form), permits a company to collect 50 storms from one site and pick their best 15, which Ocean Protect considers leaves open the potential for results to be skewed or unrepresentative of the full picture;
- Provide more detail about sampling locations and equipment setup requirements:
    - We consider this is necessary to ensure results across technologies are consistent, comparable and conservative.
    - For example, a company could make a stormwater pit obtain reductions in pollutants by simply facing the inlet sample suction line upstream to capture as much influent pollutant load as possible, and then face the effluent suction line downstream to avoid sampling as much effluent pollutant load as possible;
- Add a requirement that test sites have a minimum level of Dissolved Inorganic Nitrogen (DIN):
    - We consider this would be desirable so as not to overestimate technology performance claims obtained from sites with high levels of particulate forms of nitrogen;
    - We recommend a minimum DIN requirement of 25 to 40%, to be consistent with protocols for SQIDS enacted by the City of Gold Coast and other councils within the Sydney metropolitan area. As a comparison, the City of Gold Coast (2015) protocol "*Development Application Requirements and Performance Protocol for Proprietary Devices*" requires a minimum DIN of 40%.
- Change some sampling criteria to ensure minimums are met, including: (i) 100% compliance with minimum storm coverage; (ii) minimum of 50% hydrograph coverage; and (iii) minimum of eight aliquots per storm:

    - We consider this is necessary to remove the 'noise' and inconsistency in data that can affect performance claims, and is consistent with the existing City of Gold Coast (2015) protocol.
- Order the performance metrics in an appropriate hierarchy:
    - This is recommended to ensure that manufacturers cannot simply choose or argue the performance metric method for a particular data set that provides them the best result.
    - We recommend that if the 'efficiency ratio' (ER) and median 'concentration reduction efficiency' (CRE) differ by more than 10%, then use average ER and median CRE; and
- Add requirements and reporting for Maintenance to ensure there is not a disconnect between system sizing and associated maintenance frequencies that can disproportionately skew performance claims.

These changes have been proposed to strengthen SQIDEP, and are consistent with The City of Gold Coast evaluation (2015) protocol that has been in effect for the last two years.

Ocean Protect understands some of the largest regulators on the East coast of Australia are currently using the SQIDEP, but with additional criteria or overlay, which renders the process redundant and the $22,750 to $26,500 + GST spend per technology verification less worthwhile.

Questions in relation to conflicts of interest

In Ocean Protect's view, technical changes to SQIDEP, the determination of the verification program, and the setting of application fees have not been undertaken in thorough consultation with either regulators or manufacturers. Ocean Protect understands Stormwater Australia's Secretary and President have elected to make these decisions themselves.

In these circumstances, in the course of critically evaluating the SQIDEP and its potential improvement, Ocean Protect encourages you to consider whether an actual or perceived conflict of interest exists for Stormwater Australia executives in the making of their decisions relating to the SQIDEP. Relevant enquiries might be:

- whether or not a Stormwater Australia executive owns an interest in a company that develops SQIDs; and
- whether or not a Stormwater Australia executive has previously provided professional advice or services in relation to field testing for any SQID manufacturer – and, if so, the content of that advice and to whom and when that advice was provided.

It is Ocean Protect's view that, in the interests of transparency and good corporate governance, Stormwater Australia's President and Secretary must disclose any circumstances that do or might give rise to an actual or perceived conflict of interest relevant to the development and implementation of the SQIDEP.

Actions for your organisation to consider

Given the ethical, procedural and technical issues highlighted above, we ask that you consider undertaking the following actions to assist you to make an informed decision about the merits of, and your support for, SQIDEP and the associated evaluation framework:

1. Ask Stormwater Australia to include the aforementioned recommended changes to be made to SQIDEP[2];

[2] Contact details for Stormwater Australia are available at https://www.stormwater.asn.au/contact-us

2. Consider whether you believe Stormwater Australia executives might be conflicted in the development and implementation of the SQIDEP, and make the enquiries set out above;

3. Liaise directly with your state association in relation to the contents of SQIDEP[3];

4. Liaise directly with personnel from other regulatory organisations such as Blacktown City Council, WaterNSW, Stormwater New South Wales, Melbourne Water, The City of Gold Coast and Brisbane City Council in relation to the protocols enacted in those jurisdictions. We can provide you with contact details for suitable staff from these groups upon request; and

5. Meet with myself (and other stakeholders, if you consider appropriate) to discuss this correspondence.

I trust this is suitable for your current purposes. Just let me know if you have any questions or would like to discuss anything further.

Yours faithfully,

Michael Wicks
Technical Director

Attached: City of Gold Coast (2015). *Development Application Requirements and Performance Protocol for Proprietary Devices.* Originally Prepared by DesignFlow. Peer Reviewed and Amended by E2DesignLab.

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[3] Contact details for Stormwater Queensland are available at http://stormwaterqueensland.asn.au/contact/
Contact details for Stormwater NSW are available at http://stormwaternsw.asn.au/contact/
Contact details for Stormwater Victoria are available at https://www.stormwatervictoria.com.au/contact
Contact details for Stormwater South Australia are available at https://www.stormwatersa.asn.au/contact-us
Contact details for Stormwater Western Australia are available at https://www.stormwaterwa.asn.au/

CITY OF GOLDCOAST.

Development Application Requirements and Performance Protocol for Proprietary Devices

Originally Prepared by DesignFlow. Peer Reviewed and Amended by E2DesignLab

August 2015

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1. Introduction

Council of City of Gold Coast (Council) is increasingly receiving stormwater management plans supporting development applications which rely on proprietary devices to manage total suspended solids and nutrients. Council has decided to accept proprietary devices provided:

- The devices are located on private land, ensuring the devices are maintained by the land owners.
- The treatment performance is supported by performance monitoring, preferably within Australia, which is endorsed by an independent suitably qualified expert acceptable to Council.
- The stormwater strategy which incorporates proprietary devices must achieve the Council and State Government stormwater quality objectives for suspended solids and nutrients.
- The method used in MUSIC for modelling performance is acceptable to Council.

This document outlines Councils requirements for development applications which involve filter based cartridge proprietary stormwater treatment devices including a protocol for defining pollutant removal performance.

2. Definition of Pollutants

This document focuses on the following pollutants:

- Total suspended solids (TSS)
- Total phosphorus (TP)
- Total nitrogen (TN)

The following sections outline important characteristics of stormwater which must be considered when defining pollutant removal performance of a proprietary device, as outlined in Section 5.

2.1 Event Mean Concentrations

Table 1 and Table 2 present stormwater concentrations for TSS, TP and TN which are representative of the Gold Coast. These are the pollutant export parameters defined in the MUSIC Modelling Guidelines for South East Queensland (Water by Design) which are based on a significant set of urban stormwater quality data set collected by Brisbane City Council.

Council of City of Gold Coast and Queensland University of Technology (Goonetilleke etc. at, 2005) have collected urban stormwater quality data across a number of Gold Coast catchments which are generally consistent with the values in Table 1 and Table 2.

Table 1 Mean of Logarithmic EMC's ranges for TSS, TP and TN[1]

Pollutant	TSS (mg/L)		TP (mg/L		TN (mg/L)	
	Mean	St Dev	Mean	St Dev	Mean	St Dev
Urban residential	2.18	0.39	-0.47	0.32	0.26	0.23
Industrial	1.92	0.44	-0.59	0.36	0.25	0.32
Commercial	2.16	0.38	-0.39	0.34	0.37	0.34

[1] Value provided in MUSIC Modelling Guidelines for South East Queensland (Water by Design).

Table 2 Mean stormwater EMC's ranges for TSS, TP and TN[2]

Pollutant	TSS (mg/L)		TP (mg/L		TN (mg/L)	
	Mean	St Dev	Mean	St Dev	Mean	St Dev
Urban residential	151.4	- 90 + 220	0.34	- 0.18 + 0.37	1.82	- 0.75 + 1.27
Industrial	83.2	- 53 + 146	0.26	- 0.14 + 0.33	1.78	- 0.93 + 1.94
Commercial	144.5	- 84 + 202	0.41	- 0.22 + 0.48	2.34	- 1.27 + 2.78

Where laboratory evaluation is undertaken, the synthetic stormwater must have concentrations within one standard deviation of those identified in Table 2.

Where proprietors have completed field based performance assessment monitoring, the mean of the EMC information for all the storm events and the standard deviation (μ±σ) must be determined. Where the EMC for an individual storm event is greater than one standard deviation (μ±σ) from the mean for the site and greater than one standard deviation from the mean stormwater EMCs (i.e. Table 2), the event should be excluded from the data set collected by proprietors as part of treatment performance assessment (refer Section 5).

[2] The mean concentrations and associated standard deviations have been naturalised from the logarithmic information contained in Table 1. Therefore, the standard deviations differ on the negative and positive side of the mean.

2.2 Particle Size Distribution

The size of the particulates in stormwater has a significant influence on potential treatment performance. Review of the background material indicates there is no standard approach to define solids sizes in urban stormwater runoff. This document has adopted the following:

- Gross pollutants > 5mm
- Coarse sediment (bed load) = 0.5mm to 5mm
- Suspended sediment (including nutrients) = 0 to 0.5mm

Given Council's water quality objectives focuses on total suspended sediment (TSS), total phosphorus (TP) and total nitrogen (TN), we have considered treatment performance for particles between 0 – 0.5mm in size. Larger particles are assumed to be bed load or gross pollutants which are assessed separately in design guidance and modelling tools like MUSIC.

In some stormwater references, 1mm is used as the split between suspended sediment and coarse sediment, however, 0.5mm is generally consistent with the monitoring undertaken by Wong and Lloyd (1999), Brodie (2007) and the particle size distribution adopted by MUSIC.

Figure 1 presents the range of particle size distribution (PSD) for Australian urban stormwater quality runoff. This information is based on Drapper (2001 and 2014) which collected PSD information from 214 storm events from a range of road surfaces across South East Queensland. Treatment performance assessment by the proprietor needs to illustrate that PSD for their monitoring is consistent with the PSD range presented in Figure 1. Where the data or individual storm do not comply with the PSD, the data must be excluded from the assessment.

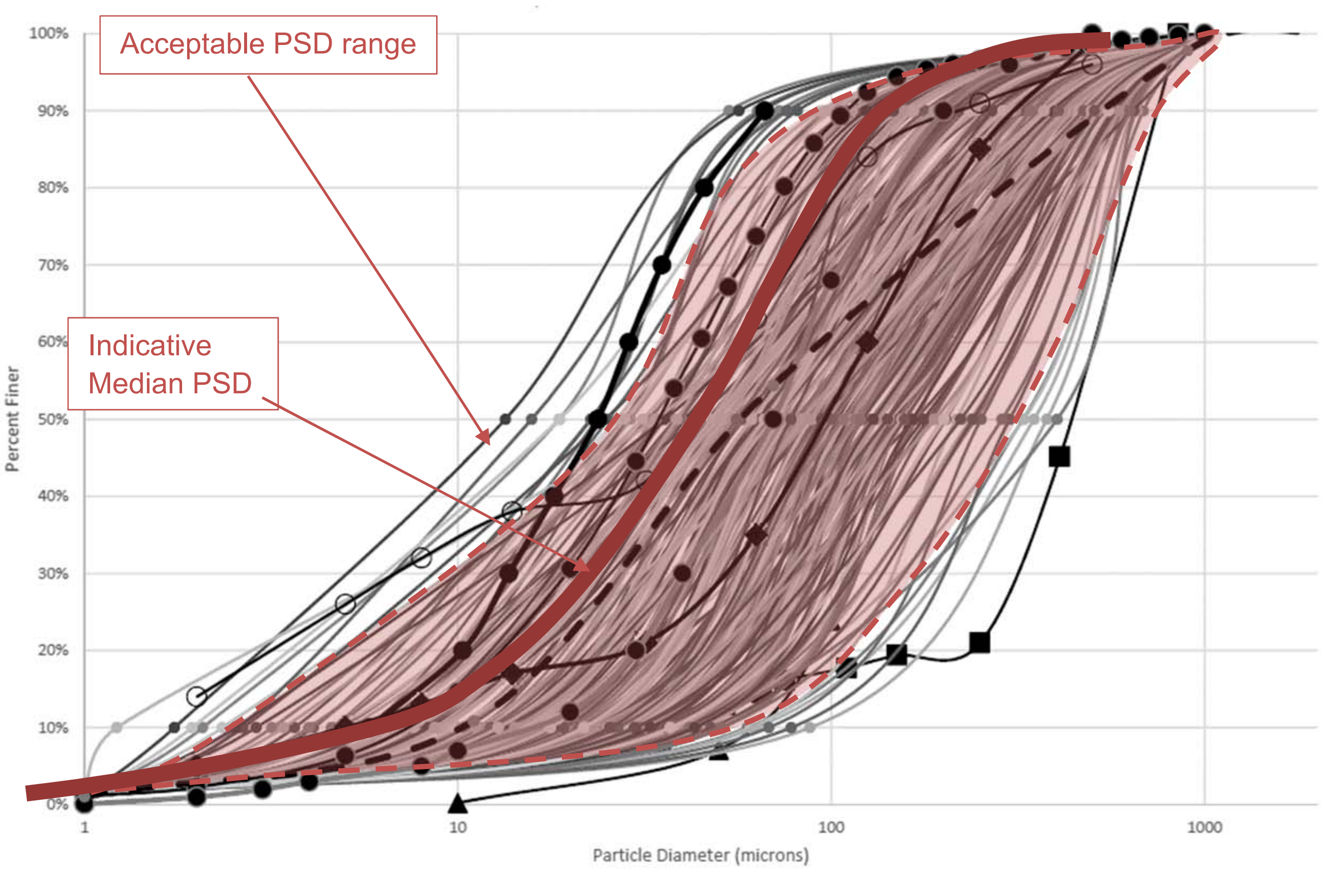

Figure 1 **Particle Size Distribution for Australia urban stormwater runoff**

2.3 Particulate Versus Dissolved Nitrogen

Nutrients in stormwater runoff existing in either particulate or dissolved forms. Particulate forms are generally easier to remove from stormwater than dissolved forms so understanding the proportion of particulate and dissolved nutrient is important when establishing pollutant removal performance. Table 3 presents the typical and minimum dissolved fractions of nitrogen for stormwater in Australia. These have been established based on Taylor et al (2005) and Parker (2010) which measures the dissolved fraction in urban stormwater runoff across a total of 40 events in Melbourne and Gold Coast.

Treatment performance assessment by proprietors needs to illustrate that the dissolved fraction for Nitrogen in the source stormwater is above the minimum values listed in Table 3. Individual events can be as low as 10% dissolved nitrogen provided the overall dataset (excluding outliers, see Section 2.1 and 2.2) has a mean dissolved nitrogen above the minimum value listed in Table 3.

Table 3 Minimum dissolved nutrient fractions for Nitrogen

Pollutant	Typical dissolved fraction	Minimum dissolved fraction
Nitrogen (TN)	approx 50%	40%

Where the dataset pre-dates this document, the collection of dissolved nitrogen may not have occurred. In this case an alternative speciation can be used to illustrate the suitability of the data as outlined in Table 4. This information has also been established based on Taylor et al (2005) and Parker (2010).

Table 4 Alternative speciation of TN (applied to datasets which pre-date this report only#)

Nitrogen Species	Typical fraction	Minimum fraction
NO_x	25-40%	20%*
NH_3	10-20%	5%*
Organic N	45-70%	-
Total Kjeldahl Nitrogen (=NH3 + organic N)	55-75%	-

All submissions to Council which occur after the date of the document must contain dissolved nitrogen fraction data in accordance with Table 4

* Alternatively the total of NOx and NH3 must be greater than 20%

3. Council Acceptance of Proprietary Devices

Filter based cartridge proprietary stormwater treatment systems may be accepted by Council provided the requirements outlined in Table 5 are achieved.

Table 5 Council Requirements for Accepting Proprietary Devices

Requirement	Detail
Located on private land	Proprietary device must be located on private property to ensure ownership and management by the ultimate private owner or manager.
Landuse is residential, industry or commercial	Proprietary device must treat stormwater from urban landuses not from rural residential, open space, rural or similar landuses. On industrial and commercial developments, the devices are intended to be targeting stormwater pollutants and not industrial pollutants. Development should seek to separate industrial and commercial activity (and pollutant risks) from surfaces exposed to rain (i.e. structural separation).
Development area maximum of 1.25ha for residential landuses	1.25ha aligns with the Water Sensitive Urban Design Deemed to Comply Solutions (Water by Design). The suitability of larger (>1.25ha) commercial and industrial sites for application of proprietary devices must be justified and will be reviewed on a case by case basis.
Assessment of proprietary device with catchment comprised entirely of roof to reflect the characteristics of roof runoff	Roof runoff - Where the filter is used to treat roof runoff directly the performance assessment must clearly illustrate treatment performance at low concentrations, typical of roof water. Also basket or mesh based systems (i.e. gross pollutant and particulate traps and filters) must not be used to treat roof runoff.
Upstream treatment systems must be considered when defining location of the proprietary device	Where filter cartridge systems are proposed downstream of other treatment systems the following applies: ▪ Rainwater tanks – Overflows from the tanks can enter the cartridge filter provided performance is proven at low concentrations. Overflow cannot enter basket or mesh based systems. ▪ Gross pollutant traps, pit inserts and swales – The outflows from the GPT, pit insert or swale can enter the filter cartridge system. Representations of performance of the cartridge filter must then include a performance relationship which varies with inflow pollutant concentration. ▪ Bioretention, wetland systems and other cartridge filter systems – The treated flows from these systems must bypass the filter cartridge system unless field testing under these conditions has established the performance characteristics of the filter.
Treatment flow rate confirmed and certified	Treatment flow rate of the device is confirmed in accordance with the protocol outlined in Section 5. This includes defining the long term flow rate across numerous

Requirement	Detail
	events / tests when the system is at least 50% full and blinded. The results are to be independently certified by a suitable qualified person acceptable to Council.
Pollutant removal performance confirmed and certified	The pollutant removal performance of the proprietary device must be illustrated through ▪ Evaluation of the performance in accordance with the protocol outlined in Section 5. ▪ Illustrating the results can be applied to the Gold Coast by confirming EMC's, PSD's and dissolved nutrient information used in the performance evaluation meet the requirements listed in Section 2 ▪ Certified by an independent suitably qualified person acceptable to Council.
MUSIC Modelling completed	MUSIC modelling must been completed in accordance with Section 4 using the correct treatment flow rates and pollutant removal performance. Where alternative approaches are proposed they must be agreed with Council prior to development application.
Hydraulic function of storage volume of treatment device must: - Exclude the cartridge volume - Exclude flood / detention storage volume	Most filter cartridge based system include a container or vault which houses the cartridges. The vault also provides temporary storage of stormwater flows to allow more volume to pass through the cartridges. The storage volume is typically set by an overflow weir just above the top of the cartridges. The storage volume must account for the lost volume associated with the cartridges. Where the proprietary device is combined with a flood (or stormwater quantity) storage then the flood storage volume does not form part of the stormwater quality storage volume function. For example, if $2m^3$ is require for the proprietary filter cartridge system and $5m^3$ is required for flood storage, the total volume is $7m^3$. When completing performance assessment in MUSIC only $2m^3$ is included in the assessment. The presumption here is that the peak flow mitigation associated with the $5m^3$ flood storage does not influence the treatment flow rate whereas the $2m^3$ does.
Pollutant removal function of storage volume of treatment device	- The manufacturer is to nominate a minimum vault storage volume per cartridge (this can include dead storage provided by a wet well). - Monitoring / testing shall then be undertaken on a configuration with no greater than this vault storage volume ratio. - Site designs are then to use a vault total storage ratio no less than the nominated minimum so that treatment performance will be no less than anticipated.

Requirement	Detail
	- The ‘treatment node’ in the MUSIC models for the development application approval will be inherently representing the nominated minimum vault storage. The actual ‘active vault storage’ of the proposed site design may however be used in the MUSIC ‘storage node’ for representation of the device’s hydraulics (bypass).
Maintenance ▪ Maintenance requirements are documented, understood by developer and communicated to the ultimate owner/body corporate/tenant. ▪ 10 year maintenance agreement confirmed and signed	The maintenance requirements for the proprietary device must be included in the Stormwater Management Plan. Prior to commencement of use and/or prior to operational works approval, the developer must enter into a 10 year maintenance contract with a reputable maintenance service provider. The contract must clearly outline maintenance frequencies, actions and associated costs. The wording of the agreement is to ensure continuance of maintenance should there be a change of land ownership (e.g. connected to the site and rolled over to new owner or held by a body corporate). This will be a condition of development. Council are exploring the options for ensuring this maintenance occurs during this 10 year period and beyond.

4. MUSIC Modelling

The MUSIC modelling approach used for proprietary devices must reflect the treatment flow rate and water quality performance research. Key information required for MUSIC modelling is:

- Treatment flow rates (above which bypass and no treatment occurs)
- Treatment performance for TSS, TP and TN (based on performance assessment protocol in Section 5)

These parameters should be inserted into MUSIC as a Generic Node directly in accordance with Table 7. Where the proprietor or developer proposes the use of multiple treatment systems in series the method of modelling needs to be carefully considered based on approved evaluation of the product's performance assessment findings and agreed with Council. For example:,

- does the performance evaluation completed by the proprietor separate the performance of the devices may lump the performance of multiple devices into a single % removal rate; the multiple devices would then be represented as a single node in the MUSIC model.
- The devices may be modelled in series if the proprietor provides a performance relationship for the downstream Generic Node which varies with inflow pollutant concentration.

Table 7 considers the representation of two types of proprietary treatment devices (Pit Insert, Filter Cartridge). Although this document and protocol focusses on filter cartridge style devices, modelling of inserts may also be required to represent both types of device in series.

Most filter cartridge based systems include a container or vault which houses the cartridges. The vault also provides temporary storage of stormwater flows to allow more volume to pass through the cartridges. MUSIC cannot currently represent the temporary storage and filtering functions of a proprietary device as a single node and are instead represented by a detention basin node and generic node together.

Table 6 MUSIC Modelling Approach and Parameters

MUSIC Parameter	Details
Applicable catchment landuse or upstream treatment	Refer Table 5
Pit Insert Device	
Node Type	Sediment Pond Node
Minimum number of Pit Inserts	Preferred minimum = 1 per 500m^2 Absolute minimum = 1 per 1000m^2
High Flow Bypass	Provided by Protocol (refer Section 5) Where pit inserts predominately operate in bypass mode (i.e. overflowing), special consideration needs to be given to the representation of inflow data. ▪ No bypass is to be allocated to the generic node representing the pit insert; and ▪ Depending on the inflow data it may be necessary to provide an outflow concentration relationship which varies with inflow rate.
Pollutant reductions	Provided by Protocol (refer Section 5)

MUSIC Parameter	Details
	Method 1: TSS = __% reduction TP = __% reduction TN = __% reduction Assigned as a reduction in concentration into and out of the Generic Node **Method 2:** Performance curve nominating different % reductions for different inflow concentrations. Trend line coordinates assign reductions in concentration into and out of the Generic Node
Filter Cartridge Device (may comprise both storage volume and filter cartridge)	
Treatment Device Storage Volume	
Node Type	Detention Basin Node
Volume	Where the treatment device's vault or storage is included in the MUSIC model as a detention basin node, its volume must be calculated as per the following: ▪ Vault volume = Volume up to weir overflow within the vault – volume of cartridges ▪ This will thus represent the actual 'active vault storage' of the site design. ▪ The volume must exclude volume associated with flood / detention objectives.
Outflow	The outflow from the detention basin must be set at the cartridge system design flow rate (i.e. number of filter cartridges x treatment flow rate of cartridge).
kC*	The storage is an underground closed type container or vault. No stormwater treatment occurs in these systems so the exponential decay parameters (k) must be set to 1. Where the monitored bypass flows demonstrate an improvement in quality, some treatment could then be attributed to the storage node. The k value applied would need to be justified and demonstrated by calibrating a MUSIC model based on the field data.
Filter Cartridge	
Node Type	Generic Node
Minimum number of cartridges	Provided by Protocol (refer Section 5) Total number of cartridges is defined by MUSIC modelling to the maximum catchment area per cartridge. The minimum number of cartridges will generally result in maintenance of the filters every year. This maintenance frequency is a guide only and will vary between sites and products with the requirement being annual maintenance or less often.

MUSIC Parameter	Details
High Flow Bypass	Provided by Protocol (refer Section 5) High flow bypass rate increased in multiples of the cartridge flow rate (i.e. increase the number of cartridges) until the desired load objectives is achieved for the site. The vault storage volume ratio must be maintained and represent the nominated minimum vault storage.
Pollutant reductions	Provided by Protocol (refer Section 5) TSS = X% reduction TP = X% reduction TN = X% reduction Assigned as a reduction in concentration into and out of the Generic Node.

5. Performance Assessment Protocol

At present there are no adopted protocols for the testing, validating and performance assessment of stormwater treatment devices in Australia (Iouriv Water Solutions, 2013). Although there has been a significant amount of performance assessment work undertaken by a number of research organisations of vegetated stormwater assets, the approach to this testing is typically included in published peer reviewed papers specific to the testing, rather than as an adopted protocol or procedures.

In terms of proprietary devices, there are a number of protocols from across the world which have been used as a basis for the completing performance assessment. But the reality is there is very little actual testing completed for proprietary devices in Australia. This has led to confusion and disagreement about whether overseas evaluation data is appropriate for Australia and whether an Australian protocol and certification process is required. This issue has been the focus of much discussion in the last 12 months and has resulted in the creation of the Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices - Consultation Release report by Stormwater Australia (December 2014). The document outlines a recommended framework for performance evaluation of stormwater treatment devices. The document has been adapted from the Proprietary Devices Evaluation Protocol for Stormwater Quality Treatment Devices (Auckland Council, December 2012).

The Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices - Consultation Release document has been released and the intention is to finalise and endorse the document in 2015.

This protocol document is prepared in line with the above SQIDEP by Stormwater Australia. Performance assessment of a proprietary device (to be proposed for a development application with City of Gold Coast) must define the following:

- Treatment flow rates
- Pollutant removal rates for TSS, TN and TP as a minimum
- Method of performance modelling (i.e. MUSIC)

The performance assessment must be completed in accordance with the following sections.

5.1 Field Evaluation

Field evaluation is the preferred method of performance assessment for the Gold Coast. The field evaluation should occur in accordance with the Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices (Stormwater Australia) and Table 7.

Table 7 is a reproduction of the minimum requirements listed in Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices (Stormwater Australia) but with some adjustments that Council consider important for application on the Gold Coast. The adjustments are provided in italics.

Table 7 Minimum field evaluation data and performance assessment requirements

Requirements	Field Evidence Criteria
Sample Events	
Location	Minimum of one Australian field test site, additional international data will be accepted
Type of Event	Rainfall events (does not include Controlled Field Tests)
Minimum Number of Events	10 events (preferably 15 events) with at least 7 events form a single location Where statistical significance is not achieved for a given parameter, then additional events will be required until the result is statistically

Requirements	Field Evidence Criteria
	significant.
Minimum Rainfall Depth	5mm and must trigger full operating mode of the cartridge filter (e.g. engage siphon flow)
Minimum Storm Duration	5 minutes
Minimum Inter-event Time	72 hours for minimum of 5 events; 6 hours for other events
Device Size	Full Scale
Runoff Characteristics	Target flow and pollutant profile of influent (inflow) and effluent (outflow)
Runoff Volume or Peak Flow	Runoff of at least 3 events should exceed 75% of the design water quality volume/treatment flow rate or capacity of the device and 1 event greater than the design flow.
Sampling procedures and Techniques	
Automated Sampling	Composite samples on a flow weight basis
Minimum Number of Aliquots	6 per event spread over the hydrograph
Hydrograph Coverage	Indicative 50% (importantly the rising and falling hydrograph components should be included in testing, and dependent on catchment and rainfall patterns, multiple peaks should be accounted for). Individual storm event reports are to be provided to Council as part of the assessment.
Manual Sampling	Only for constituents that transforms rapidly, require special preservation or adhere to bottles, or where compositing can mask the presence of some contaminants through dilution. See Section 10 of Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices - Consultation Release for details.
Sampling Location	Inflow, outflow and overflow/bypass. Where the sampling of treated flow is impractical, a float switch or similar must be used to detect and record when bypass has occurred. Sampling locations are to be identified and agreed in the submitted Quality Assurance Project Plan.
Maintenance	A typical/standard maintenance program must be in operation during the assessment period. A statutory declaration from the manufacturer as to the maintenance regime must be provided.
Analytical Methods	Various and/or Standard Methods (for organic, inorganic and biological analysis as required). Must be NATA Registered laboratory for samples.
Chemical and Physical Analytes	▪ Particle size distribution ▪ Total suspended solids (TSS) or suspended solids content (mg/L) ▪ Total phosphorus (TP) ▪ Filterable reactive phosphorus ▪ Particulate Phosphorus ▪ Total Nitrogen (TN) ▪ Dissolved Nitrogen ▪ Total Oxidised Nitrogen ▪ Ammonium Nitrogen

Requirements	Field Evidence Criteria
Flow recording 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)
Precipitation Measurement	Automatic onsite rain gauge[3]
Recording Intervals	1 minute or less
Recording Increments	No greater than 0.25mm
Rain Gauge Calibration	Twice during verification period
Data analysis and reporting	
Performance indicators	TSS, TN and TP
Data points to be excluded	▪ TSS, TN or TP EMC for an individual event if the EMC is greater than one standard deviation from the overall mean for all events and greater than one standard deviation from the mean values presented in Table 2. ▪ Individual stormwater event TSS, TP and TP EMC data if the PSD is outside the ranges provided in Figure 1. Where there is only limited PSD data is provided and the PSD is outside the ranges provided in Figure 1 then all data is excluded. ▪ TN EMC data when the dissolved and particulate requirements in Table 3 are not achieved.
Performance indicators[4]	▪ Efficiency ratio (ER = 1 – mean EMCout/ mean EMCin) ▪ Median Concentration Reduction Efficiency (CRE = (EMCin – EMCout) / EMCCin) for each event is calculated then median of the CRE's is calculated) Where there is close agreement between the parameters above then adopt the efficiency ratio. Where there is greater than 10% difference between the two parameters adopt the average. ▪ Performance curve with trend line Preferred approach as this allows different % reductions to be nominated for different inflow concentrations
Performance Variability Schematics	Box and Whisker Plot
Statistical Significance Testing	Log-transformed inlet and outlet paired samples at 95% confidence level

[3] In the event of rain gauge failure a substitute gauge from BoM (within 5 km of the site) can be used as a temporary measure. The faulty site rain gauge must be fixed promptly.
[4] The Generic Node in MUSIC uses a concentration based transformation, so the use of concentration based performance efficiency calculations are more appropriate than sum-of-loads or similar methods.

5.2 Laboratory Evaluation

Laboratory testing and controlled site testing can be adopted to illustrate performance of the proprietary device provided the testing follows the Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices (Stormwater Australia).

Pre-loading is important to reflect the average performance of a device throughout its cleanout or replacement cycle. Therefore, before performance is measured, the device is to be loaded with test cycles whose total volume equals half the runoff volume of typical urban stormwater, inflow sediment load or volume of accumulated pollutants that would provide a trigger for maintenance of the device and the corresponding maintenance frequency.

Testing of performance and treatment flow rate would commence after the device is loaded to half this level to provide indicative performance at the 'half-life' of the device. The composition of synthetic stormwater must comply with the EMCs defined in Table 2. The particle size distribution (PSD) of pre-load sediment and gross pollutants and synthetic stormwater must comply with Section 2.2 .

Where the laboratory testing has been completed in accordance with the requirements listed above the following will apply:

- Treatment flow rates will be accepted without de-rating
- No de-rating of results of laboratory testing of devices where both:
  - treatment performance is determined at the maximum flow rate before bypass occurs or where treatment performance is averaged over a range of flow rates lower than bypass and;
  - where performance under various inflow concentrations and PSD (in accordance with the protocol) has been averaged across the inflow concentrations or represented in a performance curve.
- De-rating factors will apply in accordance with the following:
  - 40% - where tests are performed with only one flow rate and one inflow concentration
  - 20%- where testing has been undertaken across a range of flow rates but with one inflow concentration.
  - 20% -where testing has been undertaken across a range of concentrations but with one flow rate (unless the flow rate is proven to be the maximum flow rate before bypass occurs).
    - "a range of flow rates" means a minimum of 3 tests at each flow rate and a minimum of 3 flow rates.
    - "a range of inflow concentrations" means a minimum of 3 tests at each concentration and a minimum of three concentrations.
    - The performance at each inflow concentration needs to be averaged across a number of flow rates.
    - Pre-loading must be undertaken in accordance with the protocol

5.2.1 Independent Certification

Performance assessment and associated claims made by the proprietor must be reviewed and approved by a suitably qualified independent expert suitably acceptable to Council. The aim of the review is to ensure performance testing and results are consistent with this document and Evaluation Protocol (SQIDEP) for

Stormwater Quality Treatment Devices (Stormwater Australia), results are statistically significant and being used properly by proprietors when selling their products and simulating the performance (e.g. MUSIC modelling).

The results of the review must be clearly documented in response to the requirements of this document.

Section 5 doesn’t provide further information on modelling these devices (as referenced in Table 6) – further guidance is required in this table or in Section 5.

6. References

Drapper (2014) *Particle Size Distribution of Urban Runoff – Australia versys International: Ten Years On* Stormwater Australia Conference

Goonetilleke, A, Thomas, E, Ginn, S, and Gilbert D (2005), *Understanding the Role of Land Use in Urban Stormwater Quality Management Journal of Environmental Management*

Parker, N (2010) *Assessing the Effectiveness of Water Sensitive Design in South East Queensland Thesis* as Part of Masters of Engineering, Queensland University of Technology

Taylor, G, Fletcher, T, Wong, T, Breen, P and Duncan, H (2005) *Nitrogen composition in urban runoff – implications for stormwater management Water Research*

Vase, J and Chiew, F (2004) *Nutrient Loads Associated with Different Sediment Sizes in Stormwater and Surface Pollutants* Journal of Environmental Engineering

7. Appendix A – Certification Pro-Forma

Standard Pro-forma for

Independent Certification of Performance Assessment of Proprietary Stormwater Treatment Device

Proposed stormwater treatment device:

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Supplier / Proprietor (name & contact details):

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I,…………………………………………….of…………………………………………, as a qualified professional, being duly authorised in this behalf, do certify that the above proprietary stormwater treatment device fulfil the requirements of the City of Gold Coast as stated in Council's Performance Assessment Protocol for the Proprietary Treatment Device (CoGC, 2015). I also confirm that this certification is based on the fulfilment of the following requirements:

1. The performance testing and results are consistent with the above protocol;
2. The results of the performance testing are statistically significant, and
3. The nutrients load reduction claim is acceptable (or appropriate).
4. Treatment flow rates have been established in accordance with the above protocol
5. Maintenance of the device will be required annual or less frequently

The outcomes of the certification are provided in the attachment as per the protocol.

I am aware that the Council of the City of Gold Coast will rely upon this certificate in accepting this proprietary device as an alternative to standard naturalised stormwater treatment device for approving a development within the city area. I am also aware that if the system fails there may be serious adverse impact on the downstream water ecosystems.

Signature: ______________________________

Name & Designation: ___________________________

Certified on: ___________ day of ________________ 20___.

For more information

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