Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices

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CONSULTATION RELEASE
Stormwater Quality Improvement Devices Evaluation Protocol (SQIDEP)

Prepared as consultation draft on behalf of Stormwater Australia by its Stormwater Quality Improvement Device Advisory Committee (SQIDAC).

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Table of Contents

1. GLOSSARY .................................................................................................................................................. 7
2. Process Overview .......................................................................................................................................... 11
3. Background to the development of a Protocol ............................................................................................ 13
4. Consultation in developing SQIDEP ........................................................................................................... 15
5. Objectives of the SQIDEP ........................................................................................................................... 15
6. Performance Claim ...................................................................................................................................... 16
7. Limitations of the Protocol .......................................................................................................................... 16
   7.1. Evaluation Routes .................................................................................................................................... 17
      7.1.1. Application Phase ............................................................................................................................ 18
      7.1.2. Body of Evidence (BoE) ..................................................................................................................... 18
      7.1.3. Local Pilot Trial (LPT) ...................................................................................................................... 19
      7.1.4. Detailed Evaluation (DE) ................................................................................................................... 19
8. Application Phase .......................................................................................................................................... 20
9. Application Phase Report and Checklists .................................................................................................... 20
   9.1. Application Assessment .......................................................................................................................... 22
10. Body of Evidence (BoE) Phase .................................................................................................................... 23
    10.1. Relevance of Historical Evidence ......................................................................................................... 23
    10.2. Body of Evidence Evaluation Process .................................................................................................... 24
    10.3. Information Accepted for BoE ................................................................................................................ 25
    10.4. Influent and Effluent information .......................................................................................................... 25
11. Minimum information requirements to support technical evaluation under SQIDEP ....................... 25
12. Local Pilot Trial (LPT) .................................................................................................................................. 29
    12.1. Initial Evaluation .................................................................................................................................... 29
    12.2. Transposing Laboratory to Field Removal Efficiency .......................................................................... 30
    12.3. Site Selection ......................................................................................................................................... 31
    12.4. Site Characteristics ............................................................................................................................... 31
    12.5. Target Sites ......................................................................................................................................... 32
       12.5.1. Roads, Highways and other trafficked areas ................................................................................... 32
       12.5.2. Industrial Sites ............................................................................................................................... 32
       12.5.3. Commercial Sites .......................................................................................................................... 32
       12.5.4. Residential Sites ........................................................................................................................... 32
       12.5.5. Additional considerations- installations ......................................................................................... 32
    12.6. Quality Assurance Project Plan (QAPP) ............................................................................................... 33
    12.7. Undertaking a Local Pilot Trial ............................................................................................................. 33

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3
12.8. Duration of LPT Phase and Extension of Time ........................................... 33
13. Detailed Evaluation Phase .............................................................................. 34
  13.1. Performance Evaluation Matrix ................................................................. 34
  13.2. Performance Evaluation Criteria ............................................................... 35
  13.2.1. Metrics to evaluate Removal Efficiency .................................................. 35
  13.2.2. Pre-treatment Provision ....................................................................... 35
  13.2.3. Sizing Methodology ............................................................................ 36
  13.2.4. Constructability .................................................................................. 36
  13.2.5. Operation and Maintenance ................................................................. 37
  13.3. Reliability of Treatment Mechanism ......................................................... 37
  13.4. Evaluation Report .................................................................................... 38
14. Field Evaluation and Quality Assurance Project Plan ...................................... 38
  14.1. Sampling and Analysis Protocol ............................................................... 39
  14.2. Role of the Performance Claim .................................................................. 39
  14.3. Quality Assurance Project Plan ................................................................ 40
  14.4. Description of Test Sites .......................................................................... 41
  14.5. Data Quality Objectives .......................................................................... 43
  14.6. Organisational Roles and Responsibilities ............................................... 43
  14.7. Storm Events ........................................................................................... 43
  14.8. Sampling Equipment .............................................................................. 45
  14.9. Automated Samplers .............................................................................. 45
  14.10. Flow Monitoring ..................................................................................... 45
      14.10.1. Accounting for internal bypass flows .................................................. 46
  14.11. Rainfall .................................................................................................. 46
  14.12. Scour ...................................................................................................... 46
  14.13. Sampling Methodology .......................................................................... 46
      14.13.1. Grab Sampling ................................................................................ 46
      14.13.2. Automated Sampling ...................................................................... 47
      14.13.3. Time-Proportional Sampling .......................................................... 47
      14.13.4. Flow-Proportional Sampling ......................................................... 47
  14.15. Sample Location ..................................................................................... 48
      14.15.1. Sample Handling ............................................................................ 51
  14.16. Sampling Quality Assurance and Quality Control .................................... 51
  14.17. Laboratory Analysis ............................................................................. 51
  14.18. Reporting ................................................................................................ 51
14.19. Performance Reporting ................................................................. 53
14.20. Non-Detects .................................................................................. 53
14.21. Framework for Reporting .............................................................. 53
14.22. Data Quality ................................................................................ 53
14.23. Performance Metrics ................................................................. 53
  14.23.1. Performance reliability and the statistical analysis of data ........... 54
  14.24.3. Relative Achievable Efficiency ................................................. 58
  14.24.4. Summation of Loads ................................................................. 60
  14.24.5. Removal Efficiency ................................................................. 60
  14.24.7. Event Mean Concentration and Mass Discharge Variability ....... 61
14.25. Statistical Significance Testing .................................................... 63
  14.25.1. Reporting Scour .................................................................. 63
15. Certification ...................................................................................... 63
16. References and further reading ....................................................... 65
Appendix A ......................................................................................... 68
QAPP Checklist .................................................................................. 68
Appendix B ......................................................................................... 69
Draft report Template ....................................................................... 69
List of Tables

Table 10-1  Minimum data and qualifying event requirements for assessment
Table 13-1  Performance Evaluation Matrix
Table 14-1  Typical Untreated Stormwater Contaminant Concentrations Selecting SQID Trial sites
Table 14-2  Recommended C* Values Based on all Parameters in the 2008 International BMP Database Summary (Geosyntec and Wright Water Engineers, 2008)

List of Figures

Figure 2-1  SQIDEP Framework
Figure 2-2  SQIDEP consultation areas
Figure 14-1  Sample location- no device bypass flows considered in analysis
Figure 14-2a Sample location- device bypass flows considered in analysis
Figure 14-2b Sample location- device bypass flows considered in analysis
Figure 14-3  Sample location- internal bypass flows accounted for
Figure 14-4  Example FBV Curve
Figure 14-5  Example Box and Whisker Plot with Explanation of Terms from Geosyntec and Wright Water Engineers (2009)*
Figure A-1  Example of a Representative Flow Weighted Composite Hydrograph Capturing Peak Flow
Figure A-2  Examples of Representative Pollutograph Sampling Hydrographs Capturing the Peak Flows
Figure A_3  Example of Non-representative Time Weighted Sampling Hydrograph Missing the Peak Flows
Figure A-4  Example of Representative Time Weighted Sampling Hydrograph Capturing Peak Flows

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1. GLOSSARY

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADT</td>
<td>Average Daily Trips</td>
<td>Traffic movement count.</td>
</tr>
<tr>
<td>AEP</td>
<td>Annual Exceedance Probability</td>
<td>Probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.</td>
</tr>
<tr>
<td>Aliquot</td>
<td>A portion of a larger whole, especially a sample taken for chemical analysis or other treatment. For the purposes of this protocol a discrete sub sample collected from a qualifying storm event.</td>
<td></td>
</tr>
<tr>
<td>APHA</td>
<td>American Public Health Association</td>
<td>Reference organisation.</td>
</tr>
<tr>
<td>ARI</td>
<td>Annual Recurrence Interval</td>
<td>Frequency of storm event.</td>
</tr>
<tr>
<td>ARQ</td>
<td>Australian Runoff Quality</td>
<td>Document published by Engineers Australia providing guidance on procedures to for the estimation of urban stormwater contaminants and associated design guidelines.</td>
</tr>
<tr>
<td>BoE</td>
<td>Body of Evidence</td>
<td>One evaluation route in the SQIDEP, incorporating existing data from other sites.</td>
</tr>
<tr>
<td>Calibration</td>
<td>Utilizing monitoring data points to adjust certain parameters used for the sizing methodology to ensure its representativeness.</td>
<td></td>
</tr>
<tr>
<td>Claimant</td>
<td>Designer, vendor or supplier of permanent Stormwater Quality Improvement Device.</td>
<td></td>
</tr>
<tr>
<td>CRE</td>
<td>Concentration Removal Efficiency</td>
<td>Ability of a device to reduce the concentration of a contaminant in stormwater.</td>
</tr>
<tr>
<td>Controlled Field Test</td>
<td>Tests on a full scale device installed in the field, using artificially-produced influent to mimic stormwater flows.</td>
<td></td>
</tr>
<tr>
<td>Effluent (or Outflow)</td>
<td>Stormwater exiting a treatment device.</td>
<td></td>
</tr>
<tr>
<td>DQO</td>
<td>Data Quality Objectives</td>
<td></td>
</tr>
<tr>
<td>Device</td>
<td>Stormwater Treatment Device</td>
<td>Any permanent, repeatable man made device, structure or system designed primarily for the improvement of stormwater quality.</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>DRP</td>
<td>Dissolved Reactive Phosphorus</td>
<td>Any form of P that reacts with reagents in a colorimetric test following filtration of the sample through a 0.45 µm filter paper.</td>
</tr>
<tr>
<td>Evaluation Panel</td>
<td></td>
<td>Independent panel set up to make final decision on whether to certify device performance.</td>
</tr>
<tr>
<td>EMC</td>
<td>Event Mean Concentration</td>
<td>Weighted average pollutant concentration that reflects varying runoff concentration over the duration of the hydrograph.</td>
</tr>
<tr>
<td>ESA</td>
<td>Equivalent Standard Axels</td>
<td>Traffic movement count.</td>
</tr>
<tr>
<td>Influent (or Inflow)</td>
<td></td>
<td>Stormwater entering a treatment device.</td>
</tr>
<tr>
<td>Inter-event Time</td>
<td></td>
<td>Time between a storm event’s end and the subsequent event’s beginning as designated by minimum time interval with no greater than 1mm of rainfall.</td>
</tr>
<tr>
<td>IQR</td>
<td>Inter Quartile Range</td>
<td>A measure of statistical dispersion, being equal to the difference between the upper and lower quartiles.</td>
</tr>
<tr>
<td>Laboratory Tests – Scale Model</td>
<td></td>
<td>Tests undertaken in the laboratory on a scaled down model of the device. NOTE this data is not accepted for this SQIDEP.</td>
</tr>
<tr>
<td>Laboratory Tests – Full Scale</td>
<td></td>
<td>Tests undertaken in the laboratory on a full scale model of the device.</td>
</tr>
<tr>
<td>LPT</td>
<td>Local Pilot Trial</td>
<td>One evaluation route in the SQIDEP, requiring field installation and monitoring of full scale device performance.</td>
</tr>
<tr>
<td>MRE</td>
<td>Mass Reduction Efficiency</td>
<td>Measure of total mass of contaminant captured by a device.</td>
</tr>
<tr>
<td>NATA</td>
<td>National Association of Testing Agencies</td>
<td>Industry peak body responsible for certifying analytical agencies to ensure technical competence in undertake specific testing and analytical methods.</td>
</tr>
<tr>
<td>Performance Metrics</td>
<td></td>
<td>Quantify pollutant removal capacity and consistency of treated effluent water quality.</td>
</tr>
<tr>
<td>PSD</td>
<td>Particle Size Distribution</td>
<td>Description of particle sizes (ranges) in stormwater flows.</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>QAPP</td>
<td>Quality Assurance Project Plan</td>
<td>Plan to show how performance testing in the field is undertaken in a way that ensures appropriate methods and procedures are followed.</td>
</tr>
<tr>
<td>RAE</td>
<td>Relative Achievable Efficiency</td>
<td>Determines pollutant removal relative to an irreducible minimum concentration or a water quality standard.</td>
</tr>
<tr>
<td>SFR</td>
<td>Specific Flow Rate</td>
<td>The flow rate through the device divided by the cross sectional area of the device.</td>
</tr>
<tr>
<td>SQIDAC</td>
<td>Stormwater Quality Improvement Device Advisory Committee</td>
<td>An advisory committee reporting to the Stormwater Australia board.</td>
</tr>
<tr>
<td>SSC</td>
<td>Suspended Sediment Concentration</td>
<td>Method for measuring sediment in stormwater. Effectively the same as Total Suspended Solids (TSS) which is the preferred term to be used to avoid confusion.</td>
</tr>
<tr>
<td>Tc</td>
<td>Time of Concentration</td>
<td>A measure of the response of a catchment to a storm event. It is the longest time required for water to flow from the most hydrologically remote point in a catchment to the catchment outlet. It is a function of the topography, geology, and land use within a catchment.</td>
</tr>
<tr>
<td>TKN</td>
<td>Total Kjeldahl Nitrogen</td>
<td>The sum of organic nitrogen, ammonia (NH3), and ammonium (NH4+) in a sample.</td>
</tr>
<tr>
<td>TN</td>
<td>Total Nitrogen</td>
<td>The sum total of organic and oxidised nitrogen species (NOX).</td>
</tr>
<tr>
<td>TP</td>
<td>Total Phosphorus</td>
<td>Sum of organic and inorganic forms of phosphorus in unfiltered water samples.</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
<td>Reference agency.</td>
</tr>
<tr>
<td>Validation</td>
<td>Utilizing known data points to confirm a result or prediction.</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>VPD</td>
<td>Vehicles Per Day</td>
<td>Traffic movement count.</td>
</tr>
<tr>
<td>WERF</td>
<td>Water Environment Research Foundation</td>
<td>(United States) Industry body and reference organisation.</td>
</tr>
</tbody>
</table>
2. Process Overview

This document has been developed to:

1. Outline a recommended framework within which the technical aspects that will allow stormwater treatment devices to be evaluated for performance and provide pathways for this to occur (summarised in Figure 2-1); and

2. Seek feedback on
   • specific technical issues raised in the drafting of this document; and
   • potential administrative and funding models to allow industry to have confidence in testing and evaluation undertaken using the recommended framework outlined in this document.

These are summarised in Figure 2-2.

![SQIDEP framework diagram]

Figure 2-1 SQIDEP framework
Light gold breakout boxes are used throughout this document to identify areas where the SQID Advisory Committee seek technical feedback and further input.

Light blue breakout boxes are used throughout this document to provide commentary on how technical protocols could relate to an industry based scheme with more formalised approaches to receiving, assessing and certifying performance claims.

Further consultation with industry is required.

Figure 2-2- SQIDEP consultation areas
3. Background to the development of a Protocol

A protocol to allow the evaluation of the performance claims made for Stormwater Quality Improvement Devices (SQIDs) is considered a long overdue piece of work, which will be of enormous benefit to the Australian stormwater industry.

Statutory requirements enshrined in National and State based legislative instruments, accompanying regulations and policy requirements point to the need to have a sound basis for assessing the performance claims of SQIDs.

Being able to verify the performance claims will lead to:

- enhanced market and environmental outcomes through better design solutions;
- appropriate sizing of devices leading to more efficient specification and investment in technologies; and
- improved levels of understanding and effective approvals processes.

A SQIDEP will provide:

- clear and detailed guidance on the evaluation of the performance of SQIDS in the Australian context; and
- a means for authorities in relevant jurisdictions to obtain confidence in the interpretation of the devices’ performance claim.

The protocol should:

- allow current and emerging technologies to be considered on an equal footing;
- provide pathways which provide clarity for research, development and innovation; and
- ultimately, provide a robust basis to underpin the stormwater industry as it seeks to provide stormwater solutions that achieve resource management, environmental and amenity outcomes.

This document has been structured to present a draft protocol for assessing the performance claims of private and or proprietary SQIDs. Key to this is the provision of clear unambiguous testing procedures, terminology & definitions and report formats.

In the most part the document presents a set of technical requirements for undertaking or evaluating testing programs and is informed by the collective knowledge and judgement of Stormwater Australia’s SQID Advisory Committee, members of which have extensive experience in the designing and undertaking testing programs and experience in technology assessment and transfer (e.g. internationally).

It is important to understand that the devices represented by this protocol will not as a general rule perform in isolation, but be required to operate within an overall treatment train in order to achieve more general performance outcomes. Consistency in terminology is paramount to allow treatment train evaluation to be carried out.
To be effective the technical protocols need to be workable and accepted by industry. As a standalone piece of work the technical protocols contribute to improving certainty in assessing performance claims of SQIDs.

It is possible to accept agreed technical testing protocols as an industry wide guideline, however building upon international experience and similar examples in other industries there may be sufficient support for acceptance, adoption and implementation of these technical protocols through the development of a scheme with more formalised approaches to receiving, assessing and certifying performance claims. The receptivity and response of industry to adopting a more encompassing approach is touched on throughout this document.

With feedback received consideration will be given to developing a broader program to support the use of technical protocols in practice.

The document includes a number of Appendices that will be further refined on the basis of feedback to this consultation draft. These will largely be in the form of checklists and templates, however the SQIDAC considered it relevant to provide a ‘feel’ of how these requirement could be referenced alongside technical requirements.

Further work will need to be undertaken in consultation with industry to complement a technical protocol and could include the addition of sections which:

- describe the policy context underpinning the need for SQIDs;
- provide a governance framework to allow performance claims to be independently verified;
- allow a resourcing model which provides long term confidence in performance claims (see process overview diagram); and
- provide further guidance on good design procedures and outcomes, operational and maintenance and life cycle costing.
4. Consultation in developing SQIDEP

This document has been prepared by Stormwater Australia’s Stormwater Quality Improvement Device Advisory Committee (SQIDAC), which was convened in 2014 to seek expert input from manufacturers and suppliers involved in the Australian marketplace.

The draft protocol (contained), which has been developed is presented for wider industry consultation and feedback is sought on its applicability in practice.

The adopted Terms of Reference for the SQIDAC are available on Stormwater Australia’s website (www.stormwater.asn.au/LINK).

At the Stormwater'14 conference (Adelaide, October 2014) approximately 50 industry professionals representing key industry sectors including: equipment suppliers, consultants, advisors, governments (local and state) as well as New Zealand and United States delegates participated in a SQID workshop. This workshop discussed industry expectations for:

- what the protocol should achieve
- what the industry would expect to be included; and
- how governance and administrative arrangements could be framed.

This workshop provided a useful point of calibration for the draft protocol and provided confidence in releasing a consultation document that is expected to largely meet industry expectations.

5. Objectives of the SQIDEP

The purpose of the SQIDEP is to provide guidance for consistent applications for, and evaluation of, permanent SQIDs. The SQIDEP aims to provide consistency on the following:

- Process for the evaluation of a device from the start of an application to the certification of performance;
- Expected processing timeframes;
- Endorsed sampling and data collecting methods;
- Acceptable laboratory and analytical methods which are appropriate for the contaminants that are monitored;
- Statistical analyses appropriate for reporting and analysing the data collected; and
- Reporting and evaluation requirements.

With this guidance, it is expected information submitted will be consistent and complete so evaluation of devices can be performed consistently, transparently, and in a timely manner.
6. Performance Claim

This protocol has been developed to allow devices to be tested to ascertain efficacy in removing a range of pollutants.

It is up to the claimant to make the claim and provide evidence to substantiate it. Subsequent sections provide further guidance on definitions/ classes of pollutants and land use classifications.

To ensure longevity of this document it is not considered useful to limit it to current, specific regulatory requirements, but rather prescribe testing and evaluation protocols based on:

- sound scientific principles; and
- data presentation that offers confidence in interpretation and acceptance of results.

Regulatory considerations can be accommodated as a matter of course in each jurisdiction. Whilst testing is unlikely to be done in the absence of a specific regulatory driver, innovation and new technology may lead to the development of regulations (or voluntary targets for pollution removal). Therefore in drafting this protocol the aim has been to establish a process to allow evidence based science to work alongside policy and regulation development.

The claimant’s Performance Claim must be specific in describing what pollutants are being targeted, and to what extent their removal is claimed across a range of catchment and hydraulic scenarios which are representative of the target market.

Importantly, the claim must provide an upper removal claim, the statistical confidence with which this can be achieved, and the corresponding treatment flow rates (not bypass flows). The extent of testing against which these outcomes are reported must also be provided.

Removal Performance Claims must include both mass and concentration outcomes, and provide a removal threshold (concentration) below which removal efficacy is not claimed. Any performance variability based on hydraulic loading or scaling issues must also be reported, with appropriate methodologies for quantifying said variability into design outcomes.

7. Limitations of the Protocol

The guidance in the SQIDEP is provided for permanent SQIDs which address stormwater quality. SQIDEP is not designed or intended to be used for temporary installations such as erosion and sediment control devices on construction sites, nor does it address devices or a Performance Claim for the management of stormwater quantity.

The approaches described are intended to be both robust and generic in nature and can be applied to both proprietary and non-proprietary SQIDs. In particular, considerations around appropriate design/ installation and maintenance should be applied to all stormwater treatment applications.

SQIDEP is has been designed to allow evaluation of a range of SQIDs. Additional guidance and definitions may be referred to in allowing claims to be made in specific pollutant categories. In these instances experimental design and evaluation should outline why altered approaches are offered and must be included in a Quality Assurance Project Plan developed in accordance with
this document. In all instances the consideration of performance claims must be transparent and demonstrated to be free from undue influence.

In making Performance Claims, claimants should be explicit in describing the pollutants targeted and limitations and exclusions, and any prerequisite conditions that must be adhered to for proper operation of the treatment technology (e.g. pre-treatments as part of a treatment train).

The original Auckland PDEP upon which this protocol was developed had its roots in evaluation performance claims of devices which were primarily intended for removal of discrete, physical pollutants (e.g. TSS).

In framing the current SQIDEP the SQIDAC recognises the challenges and necessity to develop a generic process that addresses both historical and emerging pollutants of concern.

In particular, treatment of dissolved pollutants (e.g. nutrients) requires both an understanding of the technology employed, and operational aspects to ensure treatment media are operated and replenished in accordance with specifications, and any replacement components are representative of the materials included in the verified claim.

The SQIDAC seeks industry views on how performance claims which are reliant on specific physical, chemical and biological attributes of a treatment system can be perpetuated through operational and maintenance cycles.

7.1. Evaluation Routes

The protocol has been developed to allow three evaluation routes which:

1. Reflects the current situation in the Australian marketplace where many devices compete but product development has not been guided by consistent industry standards.

2. Acknowledges the need for efficient pathways to support innovation, product development and continuous improvement; and

3. Recognises that properly conducted field testing in real world conditions which is supported by transparent and scientifically robust processes offers the highest level of confidence in the performance of SQIDs.

For some classes of pollutants which are supported by the body of scientific evidence, computer aided approaches may be able to augment laboratory testing and be considered in the assessment process.
The SQIDAC has used the Auckland City Council’s SQIDEP as a guidance document to support the development of an Australian equivalent.

It is proposed that the evaluation should be developed using a framework similar to the Auckland SQIDEP, as outlined below.

- Application Phase;
- Body of Evidence (BoE) Phase, where existing data is summarised into a Performance Report;
- Local Pilot Trial (LPT) Phase, where an LPT is undertaken;
- Detailed Evaluation Phase; and
- Certification phase.

The enable technical testing protocols to be drafted there is a need for clarity around each of the evaluation phases.

To the extent that these protocols are developed ahead of formalised application and certification processes the SQIDAC requests industry to provide feedback and recommendations to Stormwater Australia on the administration of any adopted protocol.

The views of different industry sectors including academia, consultants, regulators, contractors, local government and operators is sought.

The phases as included in the Auckland SQIDEP and how they relate to the consultation SQIDEP draft are described below.

7.1.1. Application Phase

The application phase should allow the claim being pursued to be set out clearly, with defined expectations around the quality and format of information required to undertake assessment, set out timeframes for response and offer facilities for clarifications and appeal.

Ideally an application would be made to a centralised body, which is able to undertake independent assessment of information provided and offer a clear adjudication of the outcomes in the form of an agreed performance statement.

7.1.2. Body of Evidence (BoE)

This phase would be applicable for devices that have either laboratory or field evidence that meets the minimum requirements of the SQIDEP as provided in Section 13 below.

Devices evaluated using the BoE route are required to summarize existing data using a Performance Report framework which is developed to satisfy the technical quality assurance requirements of other evaluation pathways.
7.1.3. **Local Pilot Trial (LPT)**

Local Pilot Trials are proposed for devices where the supporting evidence is insufficient to meet the minimum requirements for BoE evaluation. In this instance, a local field trial option should be provided as a formalised option to support product development.

The LPT provides an opportunity for claimants to undertake field installations for the purposes of testing the performance of a device. It is not expected that performance claims made for devices that are slated for LPT assessment will be used as the basis for making market claims until these can be substantiated by an adequate suite of testing and test results.

This phase consists of an initial evaluation, site selection, development of a Quality Assurance Project Plan (QAPP), and a local pilot trial.

For the initial evaluation, the claimant demonstrates the theoretical, laboratory or field performance of the device. Field evidence can be provided from trials that do not meet the minimum requirements of a BoE evaluation. This evidence is subjected to a desktop assessment, and further information may be requested.

When the initial performance of the device is verified, the claimant must select an appropriate site and develop a QAPP that meets the requirements of Section 12.5 is developed before commencement of the LPT. The QAPP must be developed by a suitably qualified body with demonstrated independence from parties developing the device. The qualifications and independence of this body should be explicitly stated.

Site selection and characteristics are described in Section 14.3, and the information required to describe the test site is provided in Section 14.4. When the site is accepted, the independent testing agency will issue a letter to this effect.

With all relevant information provided and verified, the application can proceed to a LPT. Information is collected, analysed and reported during the LPT. Field monitoring in the LPT is to be completed within two (2) years, unless an extension is granted. Extension of Time requests must be based on sound rationale as described later, especially the practicalities of generating quality data from qualifying events after correct installation of the device in question.

Upon completion of field monitoring, the results should be analysed and reported in an LPT Report using a standardised format. On this basis, the device can then be evaluated in detail against the Performance Claim in the Detailed Evaluation Phase.

7.1.4. **Detailed Evaluation (DE)**

The Detailed Evaluation Phase (DE) is applicable to both BoE and LPT evaluation routes. During this phase, an independent assessment agency assesses the LPT Report or the Application Phase Report (BoE) and evaluates the device against a set of prescribed criteria contained in the evaluation matrix described in Section 13.1, including the performance of a device against its Performance Claim.

The DE is a desktop exercise and requires that a complete set of relevant field testing data is provided along with supporting information.
At the completion of the DE phase it should be possible for an agency to issue a statement of performance against the original performance claim, or offer a statement on a reduced claim if the evidence presented warrants this. If a reduced performance claim was offered the claimant would have the opportunity to accept this or undertake further testing and later resubmit a new claim for assessment.

### Detailed Evaluation Phase

The DE should allow the veracity of claims to be determined by a third party independent of any testing body or any party responsible for commissioning the testing.

The DE should be a precursor to any performance certification or statement of claim being issued.

The DE should be undertaken by a panel of recognised experts with the following qualifications:

- Experience in scientific methods and scientific peer review;
- Relevant understanding of the behaviour of pollutant types for which claims being made; and
- Demonstrated independence from the testing body and organisation seeking the DE assessment.

### Certification

Certification of claims follows on from the DE phase and allows a jurisdiction wide certification or performance statement to be issued.

The certification process should be clear in what is being certified, any conditional aspects on the claim, include information on limitations of device performance and outline operational requirements for a devices performance to be maintained.

To the extent that these protocols are developed ahead of formalised application and certification processes the SQIDAC requests industry to provide feedback and recommendation to Stormwater Australia on the administration of the DE and any subsequent certification process.

### 8. Application Phase

Claimants who wish to have their SQIDs evaluated should complete and submit an application. The applicant should be notified of receipt on an application and expected timelines and notifications. This is the date from which the evaluation commences.

### 9. Application Phase Report and Checklists

The application process should allow a completed application form, application checklist, and an Application Phase Report to be provided by the claimant. The Application Phase Report should be supplied in the nominated format.
Checklists can be used to ensure that the application includes the required supporting evidence, and the applicant is able to nominate what specific information has been provided.

A Sample Application Checklist will be provided as an Appendix for the different evaluation pathways.

The Application Phase Report contains specific information that supports the device’s capabilities for stormwater treatment. The explicit requirements are as below:

a. Name and contact details of device manufacturer and/or claimant (as appropriate);

b. Specific quantitative Performance Claim which summarises the contaminant or the types of contaminants that the device can treat or reduce, and the range or levels of treatment or reduction. This shall include minimum and maximum expected performance (anticipated verifiable performance based on climatic and geologic conditions, not “ideal” or laboratory conditions. Details are described at the end of this section);

c. The Performance Claim must be supported by data obtained using scientifically robust test procedures and analytical techniques. This can include adequate documentation, third party verification, sound scientific principles, or acceptable support in credible literature. If performance data is available, the performance should be reported following the guidelines set out later in this document;

d. Catchment description of the trial site, including catchment areas served (both pervious and impervious), percentage impervious area, hydraulic connectivity on a plan, slope; location, surrounding receiving environments, catchment land-use and anticipated contaminants;

e. Other information considered relevant to the assessment of veracity of claims including areas where direct, indirect and enhanced drainage (e.g. root drainage) may be a factor influencing performance.

f. Physical description of the device, including engineering drawings showing key dimensions which determine hydraulic and treatment performance, and installation and maintenance parameters. Assessments will be made on the basis of information provided- the claimant should use judgement when providing levels of detail as subsequent alterations that deviate from the assessed submission may require re-evaluation. For the purposes of evaluation computer models plans, cross-sections and longitudinal sections of the device are considered appropriate.

g. Identification of the treatment target for the device [e.g. whether it is for pre-treatment, basic treatment (including fine solids) or enhanced treatment (e.g. very fine solids/colloidal bound material, dissolved pollutants including nutrients and chemicals);

h. Description of the technology in the device to allow scientific evaluation, including scientific basis underpinning its function, capabilities and any known limitations. This should include information about physical, chemical or biological treatment processes (e.g., evapotranspiration, debris retention/screening, gravity separation via flotation)

1 Providing that key dimensions are provided it is not necessary to submit detailed information for devices in a ‘family’ provided there is sufficient detail to verify scale relationships and the ability for each device in the ‘family’ to operate within its required treatment envelope (e.g. flow profile, residence time, in device distribution).
or sedimentation, chemical treatment, filtration, adsorption/absorption, settling or inertial separation) involved in the overall treatment process of the device;

i. If the device consists of several components, information on the integration of the components into the overall system that is necessary for proper functioning. This should include relevant information on siting of individual components as part of a treatment train, installation of components and any commissioning checks that need to be undertaken to ensure proper functioning. If up-stream treatment is necessary for proper function this should be noted plus any information on the required quality of influent;

j. If the device has been developed overseas, note any differences in design and / or materials used for local installations (e.g. filter media used or membrane specifications). This should extend to provide a quality assurance plan for the use of equivalent materials if they are to be sourced differently to the original testing.

k. If the device relies on replaceable or consumable elements for treatment function, it should be demonstrated how these materials are able to be sourced to ensure consistency with the tested specifications and include relevant quality assurance procedures to support this outcome;

l. Sufficient installation information to provide confidence that the device can be installed correctly by a competent, suitably qualified contractor. It is not the responsibility of the claimant to detail all aspects of installation, however ground or catchment conditions which may affect longevity or performance of the device once installed should be provided (e.g Acid Sulphate Soils that potentially impact on structural integrity).

m. Recommendations on design sizing, operation and maintenance requirements. These can extend to include preventative (i.e. maintain before treatment capacity is reached) and corrective maintenance (i.e. monitor and maintain when performance threshold is reached) measures. This guidance should extend to cover target land uses.

n. Operation and maintenance information relevant to the ability to ensure proper functioning of the device. This should contain details of the personnel, qualifications, any specialist equipment required, supplies, description and availability of replacement materials and parts, equipment needed to operate and maintain the device, recommended maintenance schedule, access port details, and any special disposal requirements2;

o. Characteristic description of the land use the device can be used to treat based on nominated treatment outcomes (e.g. pre-treatment, basic, enhanced).

9.1. Application Assessment

The application assessment process should commence with a basic information check and verify the contents of the Application report against the information checklists that are provided.

The process could be adapted to ensure that all required information is received prior to detailed evaluation being undertaken.

2 It is intended that this protocol will a basis to ensure that SQIDs can be installed on a basis of confidence in their performance. This does not extend to situations where devices are not operated in an appropriate manner relative to pollutant and hydraulic loads.

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Once the application has been received in full the applicant should receive acknowledgement estimates of assessment timeframes.

After the application has been received additional information may be requested as part of the assessment process. If this is the case additional information requests should indicate the reasons for the further information request. Once additional information is received, any impacts on assessment timelines should be provided.

Application Assessment

There is considerable amount of information that is required to be submitted as part of the application assessment, and to adequately consider detail provided any receiving authority should be suitably resourced with appropriately qualified personnel.

Feedback on the application assessment seeks commentary and/or suggestions on how applications should be received and assessed, and the willingness of different industry sectors to contribute towards a resourcing model.

In particular SQIDAC is interested in understanding how the assessment of device claims could be of benefit to industry practitioners by either streamlining the process of understanding performance claims, leading to greater job effectiveness or leading to process efficiencies.

10. **Body of Evidence (BoE) Phase**

This section only applies to devices which undergo the BoE evaluation route.

10.1. **Relevance of Historical Evidence**

Stormwater Australia acknowledges the significant resources used to verify the performance of a device. However, knowledge and methods improve over time.

Historic evidence should only be accepted if the sampling and analytical methods were considered adequate based on the level and accuracy of information when compared with present day standards and the SQIDEP.

Importantly, the ability to match influent and effluent samples (on a mass, concentration basis or both) and relevant catchment and hydraulic conditions will be crucial to proper interpretation of historical data against this protocol.

Examples of where historical evidence may be considered suitable include:

a. Testing that was performed using analytical laboratory methods that are not as sensitive as present day techniques (e.g. higher limits of reporting). In this instance performance claims may be considered at the higher concentrations, but the ability of a device to achieve removal down to low levels may need further substantiation;
b. Testing comprising multiple parameters collected using differing field and laboratory techniques but sufficient to support a consistent conclusion based on sound scientific reasoning.

c. Testing undertaken by a suitably qualified body with demonstrated independence from the parties developing the device have undertaken the testing.

The ability to use scientifically good quality, historical data is considered to be an important feature of a robust and efficient process.

It is considered that a significant portion of historical information that was developed using reputable science and techniques should be able to be considered.

Suggested areas where historical data could be scrutinised include:

- completeness of data, including evidence of statistically relevant variability in testing results; and
- analytical and field techniques used.

The SQIDAC seeks feedback regarding how historical data could be assimilated into assessments and performance claims into the future.

10.2. Body of Evidence Evaluation Process

Stormwater Australia recognizes and acknowledges the financial commitment required by the claimant to verify the performance of a device. A BoE evaluation reduces the verification costs by allowing the use of existing data, provided it is sufficient and scientifically robust according to the terms outlined in this SQIDEP.

As part of the BoE application, the type and origin of information provided is assessed, including whether the information has previously been evaluated as part of a reputable, international peer reviewed performance verification process and examines how robust these methods are against the SQIDEP requirements.

The process of sampling used in any testing regime that forms the basis for consideration in the BoE pathway should comply with the guidelines recommended in the Quality Assurance Project Plan for Local Pilot Trials, which are presented later in this document. This should form part of the application process and be detailed in a Performance Report, following the guidelines outlined in Section 14. If the information provided meets the requirements of SQIDEP, the application proceeds to the Detailed Evaluation Phase, as described in Section 13. Otherwise, the claimant can withdraw or amend the application to follow the LPT route.

Table 10-1 summarises the minimum requirements in terms of the nature (laboratory or field evaluations) and quantity (number of sites, number and characteristics of storm events) of information for BoE (or indeed any) evaluation.
10.3. Information Accepted for BoE

In general, devices can be tested via laboratory scale models, full scale devices in laboratory tests, controlled field tests, or field tests. Evidence from the last three types of test are accepted for this SQIDEP, evidence from laboratory scale models is not accepted as a prima facie basis for full compliance against the SQIDEP.

Controlled field tests are those carried out in the field with full-scale devices. Influent flowing into the device is artificially sourced. Flows are typically from artificial sources which can generate the flow rate required. The artificial runoff is mixed with the contaminant of interest, which is fed to the device as artificially sourced influent. In the case of TSS, particles with a known particle size distribution (PSD) are required to produce ‘contaminated runoff’, which is fed to the device as artificially sourced influent. Information required for controlled field tests is equivalent to that for full-scale laboratory tests.

10.4. Influent and Effluent information

Under BoE assessment the condition of influent and effluent should be presented on both a mass and concentration basis to allow performance to be calculated across a range of metrics.

Influent and effluent conditions should be ‘matched’ through the device in order that a ‘like by like’ comparison can be made which accounts for any time lags through the device, storage function and treatment residence time.

There is a considerable body of knowledge on the treatment performance of devices for removal of Total Suspended Solids (TSS).

The SQID Advisory Committee seeks feedback and further input into options for standardising the particle size ranges reported for TSS removal to be consistent with accepted soil and engineering definitions.

Any recommended definition of particle ranges for reporting would need to consider the ability to accommodate historical data, and would set upper and lower limits for consideration under the TSS definition.

11. Minimum information requirements to support technical evaluation under SQIDEP

Table 10-1 outlines the minimum testing considerations required for compliance with the SQIDEP, offers suggestions/recommendations for minimum test requirements. In several areas relating to the SQIDAC seek further scientific input as outlined in sections below.
Table 10-1  Minimum data and qualifying event requirements for assessment

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Field Evidence Criteria</th>
<th>Full Scale Laboratory Evidence Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sampling Events</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Event</td>
<td>Rainfall Events¹</td>
<td>Test Runs² ³</td>
</tr>
<tr>
<td>Minimum Number of Events</td>
<td>Statistically relevant. Minimum of 10-15 (to be confirmed)</td>
<td>15 (minimum 3 at each flow rate)</td>
</tr>
<tr>
<td>Minimum Rainfall Depth</td>
<td>Total event rainfall depth ≥2mm</td>
<td>³ tests each at a constant flow rate of 25, 50, 75, 100, and 125 percent of the treatable flow rate; (for TSS) loaded with an initial sediment loading of 50% of the unit’s capture capacity</td>
</tr>
<tr>
<td>Minimum/ Maximum Storm Duration/ Volume</td>
<td>Indicative 1 hour – Importantly, the minimum storm event should relate to the hydrograph and include a consideration of catchment characteristics and may need to be adjusted based on site selection.</td>
<td></td>
</tr>
<tr>
<td>Minimum Interevent Time</td>
<td>72 hours. * (see discussion points following)</td>
<td></td>
</tr>
<tr>
<td>Device Size</td>
<td>Full Scale</td>
<td>Full Scale</td>
</tr>
<tr>
<td>Runoff Characteristics</td>
<td>Target pollutant profile of influent and effluent</td>
<td>(for TSS) Particle size distribution of influent and effluent otherwise Target pollutant profile of influent and effluent</td>
</tr>
<tr>
<td>Runoff Volume or Peak Flow</td>
<td>Runoff at least 3 events should exceed 75% of the design water quality volume/treatment flow rates of the design &amp; 1 event greater than the design flow</td>
<td>See rainfall depth comments above</td>
</tr>
<tr>
<td><strong>Sampling Procedures and Techniques</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automated Sampling</td>
<td>Composite samples on a flow weighted basis</td>
<td></td>
</tr>
<tr>
<td>Minimum Number of Aliquots</td>
<td>8 per event* (see discussion points following)</td>
<td></td>
</tr>
<tr>
<td>Hydrograph coverage</td>
<td>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).</td>
<td>Information outlining criteria for establishing laboratory testing and relationship with real world storm events</td>
</tr>
<tr>
<td>Manual Sampling</td>
<td>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 for details.</td>
<td></td>
</tr>
<tr>
<td>Sampling Location</td>
<td>As identified and agreed in the submitted QAPP</td>
<td></td>
</tr>
<tr>
<td>Analytical Methods</td>
<td>Various (refer to agreed EPA reference document) and/or Standard Methods (for organic, inorganic and biological analysis as required)</td>
<td></td>
</tr>
<tr>
<td>Chemical and Physical analytes</td>
<td>As identified and agreed in the submitted QAPP</td>
<td></td>
</tr>
<tr>
<td><strong>Requirements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Measurement Location</td>
<td>Inlet, Outlet and Bypass*, as applicable. Based on relevant accepted measurement protocols for flow type (e.g. open channel, in pipe)</td>
<td></td>
</tr>
<tr>
<td>Precipitation Measurement</td>
<td>Automatic rain gauge</td>
<td></td>
</tr>
<tr>
<td>Recording Intervals</td>
<td>5 minutes or less</td>
<td>N/A</td>
</tr>
<tr>
<td>Recording Increments</td>
<td>No greater than 0.25mm</td>
<td></td>
</tr>
<tr>
<td>Rain Gauge Calibration</td>
<td>Twice during verification period</td>
<td></td>
</tr>
</tbody>
</table>

¹ Must not include Controlled Field Tests. See glossary for the definition of controlled field tests.
² Includes Controlled Field Tests. See glossary for the definition of controlled field tests.
³ From 1 site or minimum of 8 per site if more than one site is used
| Data Analysis and Reporting | Based on the Performance Claim stated in Detailed Evaluation Report.  
(Can include but not limited to TSS, Metals, TPH, TP & TKN) |
|-----------------------------|-----------------------------------------------------------------|
| **Performance Indicators**  | **Calculation**  
1. Percent Concentration Removal (See Section 14.24) (Arithmetic average and median. If difference is 10% or greater, inspect data set closely)  
2. Percent Mass Removal (See Section 14.24) (Arithmetic average and median. If difference is 10% or greater, inspect data set closely)  
3. Relative Achievable Efficiency (See Section 14.24) (Arithmetic average and median. If difference is 10% or greater, inspect data set closely)  
4. Summation of loads (See Section 14.24) (Arithmetic Average and median. If difference is greater than 10% inspect dataset closely)  
5. Efficiency Ratio (See Section 14.24) (Arithmetic Average and median. If difference is greater than 10% inspect dataset closely)  
6. Flow Based Variability (FBV) (See Section 14.24), including a plot of one of the above performance measures against the 25, 50, 75, 100 and 125 percent of the treatable flow rate. | Individual removal efficiency of each test run; average runs for each operating rate; average for all runs |
| **Performance Variability**  | **Schematics**  
Box and Whisker Plot |
| **Statistical Significance Testing** | Log-transformed inlet and outlet paired samples at 90% confidence level |
| **Sizing Methodology** | See Section 13.2.4 |
The SQIDAC seeks Commentary/ feedback on the following aspect of Table 10-1.

**Sampling events**

**Minimum rainfall depth.**

2mm is suggested. Is this considered satisfactory, or are other thresholds more appropriate.

High thresholds may result in extended testing programs. Low storm depths which generate sufficiently polluted runoff to allow device operation to be tested may be adequate and an assessment based on quality of data may be more appropriate.

**Minimum/ maximum storm duration/ volume**

Indicative 1 hour is suggested for the minimum, however there is some concern that statistically relevant storm events may be rare and a shorter duration may be appropriate.

No maximum time for a storm event is recommended, however there are limits on the number of samples that can be collected, and hydrograph requirements (see Appendix 3) must be demonstrated.

**Minimum inter-event time.**

Three days (72 hours) is suggested and is based on the realities of collecting field samples, resetting field equipment and delivery to analytical facilities to meet quality assurance requirements and allows sufficient time for pollutant build-up in catchment.

**Sampling Procedures and Techniques**

**Minimum number of aliquots**

The minimum number of aliquots is suggested at 8, however in the experience of SQIDAC the capabilities of the field equipment limits the ability to collect samples within a specified timeframe.

Higher numbers of aliquots may require longer storm durations, and in some areas where rainfall patterns are characterised by short durations could add to the time required to collect sufficient qualifying data.

It may not add to the scientific consideration of performance to omit samples on the basis of too few aliquots where all other indicators indicate a qualifying storm event.

The SQIDAC is interested to understand how many aliquots would be considered to be justified on a scientific basis.

**Flow measurement**

Accurate measurement of bypass flows may prove difficult and the SQIDAC is interested in understanding if specific knowledge of bypass flows (as opposed to being in bypass) will add additional value when considering the performance of the device and ultimately the usefulness of this information in informing practical design outcomes.

**Performance indicators calculation**

The SQIDAC recommends the presentation of 6 metrics to allow a robust assessment of consistency of the data set, minimise the influence of outliers in the performance evaluation and allow potential for regulations to consider options to move beyond simple pollutant reduction targets.
12. Local Pilot Trial (LPT)

This section only applies to devices which undergo the LPT evaluation route.

The LPT Phase provides a pathway for consideration of performance claims and may be useful in supporting innovation and new market entrants. The LPT Phase has an initial evaluation which is a desktop exercise, a site selection stage, development of a Quality Assurance Project Plan, and an in-the-field (local pilot) trial.

If, from an initial evaluation, an independent testing agency is satisfied that the device is likely to perform as a functional stormwater quality improvement device, an appropriate LPT site can be selected. When the appropriate site is selected it may be necessary to seek permission from the relevant authority for the installation of the device for the purpose of undertaking a LPT. In this instance it is considered that the protocol will provide a supportive context for negotiation of approvals.

The LPT allows collection and reporting of field data in real world situations.

12.1. Initial Evaluation

The objective of the initial evaluation of the LPT Phase is to ensure that the device has the potential to perform as a stormwater quality improvement device, before permitting field trials at sites across Australia.

The following types of evidence are accepted:

a. Theoretical supporting evidence of the device’s performance; and/or
b. Laboratory studies or controlled field tests demonstrating the device’s performance; and/or
   c. Documentation of the device’s performance. For the purpose of initial evaluation documentary evidence can be less than minimum requirement for a BoE evaluation, but should be credibly reviewed.

The time frame to complete the initial evaluation will be determined through the overarching processes which support the administration of the scheme.

**Evaluation Timeframes**

The SQIDAC recognises the interplay between evaluation timeframes and available resources, but considers for the purposes of an initial evaluation a timeframe of 30 days is adequate provided information is able to be presented in a systemised manner.

Excessive delays in initial approval are likely to act as a disincentive to innovation.

The SQIDAC would be interested in the views of industry to determine acceptable timeframes.
12.2. Transposing Laboratory to Field Removal Efficiency

Laboratory testing is often a necessary step in the research and development cycle and offers a pathway for innovation often providing a certainty to justify undertaking more costly and involved field testing.

During the pilot scale testing phase it is considered optimal that the actual target performance is included in the testing methodology to ensure correct sizing of device in the catchment context and a more representative consideration of maintenance requirements.

The end result of the testing and evaluation will be to prove a claim found (or not), and claimants should not make specific statements about actual performance until such time this has occurred.

The decision to install a pilot scale testing facility is one for negotiation between the claimant and site owner. Expectations around long term performance, removal of unsatisfactory devices etc are for negotiation outside the SQIDEP.

For devices, which have been tested utilising a full-scale device in a laboratory or a controlled field test, the claimant will be able to claim a de-rated level of performance.

The SQIDAC considers that until the performance of a device is proven in the field there may remain some questions as to the veracity of claims.

There needs to be protection against ambit claims being made which over reach likely performance.

The SQIDAC seeks views on mechanisms to consider and manage ambit claims through a ‘de-rating’ approach and seeks feedback on whether a blanket reduction in performance (e.g. 50%) is appropriate or a more considered approach could be used.

As above, if the claims made when advocating a device for field testing are not substantiated, there is a legacy risk associated with an inappropriately sized asset being installed.

The SQIDAC seeks feedback on mechanisms to consider and manage unproven performance claims and if technical or simplified approaches are preferred.

For a de-rated performance claim to be considered, supporting evidence should be provided for review based on testing undertaken and should include at a minimum:

a. Name and contact details of device manufacturer and of claimant;

b. Intended quantitative Performance Claim supported by appropriate testing and modelling and theory;

c. If controlled field test has been undertaken, details of the trial site and indicative relationship to real world conditions (e.g. catchment areas served, hydraulic range for treatment, and relationship to treatment train);

d. Desirable field site for further testing, including location, surrounding receiving environments, catchment land-use and expected contaminants;
e. Description of the device, including engineering drawings showing key dimensions which relate to hydraulic and treatment performance;

f. Expected installation and maintenance parameters;

g. Identification of the treatment target for the device;

h. Description of the technology in the device to allow scientific evaluation, including scientific basis underpinning its function, capabilities and any known limitations;

i. Information on the integration of the components to ensure desirable operation if relevant;

j. Location specific parameters in relation to the design (e.g. does the device require materials of local provenance such as filter media) and if so, draft quality assurance plans to provide confidence that performance parameters will be maintained;

k. Sufficient installation information or practical support to provide confidence that the device can be installed correctly;

l. Indicative recommendations on design sizing, operation and maintenance requirements; and

m. Indicative operation and maintenance information relevant to the ability to ensure proper functioning of the device.

12.3. Site Selection

The claimant chooses an appropriate site to install the device for monitoring and testing. Consideration leading to the site selection should be included in the QAPP.

12.4. Site Characteristics

The characteristics of the site must align well with the land use stated in the Performance Claim, and fit one of the descriptions provided below. It is recommended that the claimant correlates the performance claim for a range of influent characteristics and water quality distributions as outlined in Section 14.4 of this protocol. If the claimant wishes to trial the device on more than one site, the number of sites chosen and their justification to toward contributing to a robust dataset must be justified in the QAPP.

When selecting sites it is important that the pollutant loads are characteristic of intended market segments. Sites with low pollutant loads are likely to produce inconclusive results due to low influent concentrations.

It is highly recommended that devices are not installed in a catchment that is discharging to a sensitive receiving environment. Until a device’s capabilities are able to be sufficiently assessed there remains a risk to the receiving environment. In additional to environmental risks there are potential reputational and regulatory risks to parties that are involved in testing programs that could be perceived as reckless, particularly if devices are ultimately judged to perform poorly.

The catchment size, flow paths, and time of concentration need to be considered against the physical limitations of automatic sampling equipment requirements. For example, enough runoff must be generated to enable an automatic sampler to pre-purge prior to taking a sample, and the time of concentration needs to be longer than the purging cycle (generally in the order of five minutes).
Any laboratory analysis undertaken to evaluate the trial sites shall use accepted methods that are provided by National Association of Testing Authorities, Australia (NATA) accredited facilities, relevant to the pollutant target, removal ranges and reporting limits.

### 12.5. Target Sites

It is expected that devices will be marketed to treat suites of pollutant expected to be characteristic of runoff from a number of generic land uses.

Typical site classifications are as follows:

12.5.1. **Roads, Highways and other trafficked areas**

Trafficked areas, namely transportation infrastructure such as roads, highways, parking lots, and other trafficked areas, require a specific trial site for this classification.

The contaminants from trafficked areas are different to those from typical residential and commercial sites. Hence, monitoring data collected from residential and commercial sites cannot be used for the evaluation of the performance of the device for trafficked sites (WSDE, 2004). Types of trafficked area need to be characterised according to vehicle usage, using annual average daily trips (AADT), equivalent standard axles (ESA) or vehicle movements per day (VPD).

The monitoring data collected from one trafficked test site is considered comparable to other sites provided all sites have similar ADT’s. Data from these comparable sites can be pooled for the Detailed Evaluation.

12.5.2. **Industrial Sites**

The concentration and variety of contaminants on industrial sites varies with the activities carried out, and no ‘typical’ industrial site exists. Hence, evaluation and certification is based on actual runoff quality, and can only be provided for other sites that have similar runoff quality characteristics as the test site.

12.5.3. **Commercial Sites**

Pollution from commercial sites will be characterised by the nature of commercial activities, and can generally be expected to contain atmospheric deposition and build-up, impacts from traffic and waste generation, accidental spills and illegal discharges.

12.5.4. **Residential Sites**

Pollution associated with residential activities and generally includes atmospheric deposition, traffic, garden chemicals, organic material such as garden waste, lawn clippings, litter, animal wastes and discharge from swimming pools.

12.5.5. **Additional considerations- installations**

The SQIDs evaluated for use in the LPT are to be installed with appropriate levels of care in accordance with installation recommendation. Factors such as scaling, temperature effects and different particle size distributions will affect the performance of the device during the LPT Phase.

Information on the device and its LPT site(s) may assist in ensuring future installations are undertaken correctly. For pilot stage evaluation it is considered appropriate that insights learnt from installation should be fed into a continuous improvement regime.
Where identified, explanations of sub-standard performance resulting from installation should not prejudice refinements to the QAPP and therefore further testing.

### 12.6. Quality Assurance Project Plan (QAPP)

A QAPP that meets the requirements described in Section 14.3 must be developed and agreed before commencement of the LPT. The claimant must develop the QAPP in consultation with the independent testing body.

### 12.7. Undertaking a Local Pilot Trial

After site selection has been approved by an independent testing agency and a QAPP has been developed and accepted by same, claimants engage parties to undertake the LPT as proposed in the QAPP. The data collected from the LPT is then statistically analysed and reported as set out in Sections 14.19 through to 14.24.

The LPT should be carried out by appropriately trained and experienced personnel. The field personnel should have adequate field sampling experience. Field sampling shall be undertaken by an independent agency (free from conflict of interest). Good discussions of relevant field sampling techniques are provided in the references below:


### 12.8. Duration of LPT Phase and Extension of Time

Typically the LPT duration shall not be greater than two (2) years to allow the required number of qualifying rain event samples to be collected. Based on an assessment of the information collected an independent testing body may recommend a time extension.

The decision to seek a LPT time extension is likely to be considered on a commercial basis by the claimant.

In considering an extension of time request an evaluator would need to determine that the information does not support a conclusive determination and further data is required to achieve
13. Detailed Evaluation Phase

The Detailed Evaluation Phase allows the claims made by claimants to be considered by an independent party who should have no conflicts of interests with either the parties commissioning testing or those who are undertaking testing activities.

The purpose of the detailed evaluation should be to provide a definitive statement either accepting or rejecting a performance claim.

The detailed evaluation phase considers the completeness of the information provided as a prerequisite for achieving a pass (i.e. have all relevant test data and supporting evidence been provided). In order for a performance claim to be accepted a Pass needs to be registered against each criteria in the performance evaluation matrix.

13.1. Performance Evaluation Matrix

This section describes the parametric Evaluation Matrix, which has been developed to standardise the Detailed Evaluation and allows evaluation to be undertaken in a consistent, transparent and accountable manner based on reported performance.

The evaluation matrix allows a pass/ fail assessment to be made against each of the performance criteria, which are summarised in Table 13-1 and further explained in subsequent sections.

Table 13-1: Performance Evaluation Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Outcome</th>
<th>Notes/ requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptability of QAPP and data provided in accordance with the plan.</td>
<td>Pass/ Fail</td>
<td></td>
</tr>
<tr>
<td>Statistical evidence supports claimed Removal Efficiency and performance reliability</td>
<td>Pass/ Fail*</td>
<td>Complying data set (e.g. qualifying event criteria met) and statistical evidence of claim being achieved from data provided</td>
</tr>
<tr>
<td>Land Uses and Limitations of Application</td>
<td>Pass/ Fail</td>
<td>Statement of intended land use and relevant target markets as determined by substantiated claims</td>
</tr>
<tr>
<td>Pre-Treatment</td>
<td>Pass/ Fail</td>
<td>Information provided on any pre-treatment requirements and application of device as part of a treatment train deployment</td>
</tr>
<tr>
<td>Sizing Methodology</td>
<td>Pass/ Fail</td>
<td>Technically robust methods provided and accepted which will allow extrapolation of performance claims to</td>
</tr>
</tbody>
</table>
devices utilising treatment techniques within a defined family of devices

<table>
<thead>
<tr>
<th>Constructability</th>
<th>Pass/ Fail</th>
<th>Relevant information for installation is provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation and Maintenance</td>
<td>Pass/ Fail</td>
<td>Operation and maintenance manuals are provided and consistent with testing procedures.</td>
</tr>
<tr>
<td>Reliability of treatment mechanism</td>
<td>Pass/ Fail**</td>
<td>Have limitations/ qualifications been placed on the reliability of the treatment performance (i.e. are there circumstances where it would be inappropriate to use the device), and if so an assessment of the acceptability of this advice.</td>
</tr>
</tbody>
</table>

*reduced performance claims may be offered if substantiated by information provided

**limitations or qualifications can be included based on recommendations from evaluation authority

13.2. Performance Evaluation Criteria

13.2.1. Metrics to evaluate Removal Efficiency

The performance of a device is highly dependent on its ability to remove the contaminant of concern. There are six primary measures of removal efficiency recommended for the SQIDEP; the QAPP should ensure that data collection methods and scope are sufficient to ensure multiple metrics can be calculated from data collected during subsequent analysis phase.

At a minimum two removal metrics should be reported along with a non-parametric, statistical test concluding complementary interpretation of performance results for high levels of confidence in results.

Removal metrics, minimum requirements and methods for calculation are described in Section 14.24.

13.2.2. Pre-treatment Provision

The provision of pre-treatment may increase the maintenance interval and life span of a device.

It is important that the removal efficiency of any pre-treatment be excluded from the calculation of the removal efficiency of the device, unless it is an integral part of the device, in which case the performance claims would need to be presented accordingly.

While pre-treatment provisions may increase the life span of a device, the reliability of the pre-treatment in the containment of pollutants and the prevention of re-suspension needs to be assessed separately.
The evaluation process should enable satisfaction that pre-treatment is consistent with recommended installation of the device, the correct location/position of the device in a treatment train and supported by maintenance and operational instructions provided for the target pollutant.

The claimed performance is able to be qualified on the basis that pre-treatment conditions are met.

13.2.3. Sizing Methodology
Several facets need to be accounted for in the sizing methodology. An inappropriate sizing methodology will result in an inappropriately sized device which may not perform as claimed. The facets are as follows.

a. A sizing methodology must be provided.
b. The basis of the sizing methodology must be provided.
c. The sizing methodology needs to be appropriate for the treatment mechanism of the device.
d. The pollutant concentration or mass removal efficiency at design flow must be equal or exceed the Performance Claim.
e. The proportion of Water Quality Volume and/or Flow Rate (as appropriate) the device can treat must be provided.
f. The sizing of the device is highly affected by the model used to calculate runoff from the design rainfall event. This will directly affect the theoretically computed removal efficiency of the device during the design rainfall event.

g. Methods to account for variability of treatment performance efficiency with flow rate.
h. The operating head for the design flow rate which the performance is based on must be provided.
i. The PSD of any filtration or biofiltration media must be specified.

j. If applicable, scaling effects should be accounted for in the sizing methodology.
k. The consideration of scour or by-pass flow and how this affects the performance of the device during high flow events is required.
l. The level of confidence of the proposed sizing methodology is evaluated against the basis of which the methodology is derived from.

13.2.4. Constructability
Basic information to ensure those facets of constructability that affect the performance of a device must be provided as part of evaluation. This should be presented as general information that is able to be understood by competent installers (as would be the case for normal deployment).

Factors that should be included (as required) are:
a. The level of involvement the claimant has during the construction of the device.

b. The level of skill or training required for installation, structural integrity, water tightness and housing.

13.2.5. **Operation and Maintenance**

It is essential that an Operation and Maintenance Manual is provided. The manual should set out recommendations for operational strategies and include as a minimum maintenance frequencies based on catchment characteristics, pollutant loads and device sizing, and recommended operational and maintenance regimes (i.e. not excessively intensive during testing) should be in place during the testing.

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**Performance versus Operational considerations**

The SQIDAC recognises the interplay between ideal performance and operational performance of devices.

For the purposes of conducting performance tests it is likely that operational aspects will be optimised (that is, the testing regime should ensure adequate maintenance is performed) and these requirements are provided as qualifiers in the final assessment outcomes.

Factors such as operational costs, resource implications and equipment requirements are likely to be considered by each authority that ultimately chooses to adopt a device and it is not within the scope of this protocol to provide definitive recommendations on these.

The SQIDAC is interested in the views of industry on how to present operational considerations and provide clear guidance on how these aspects can be considered by separate agencies.

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13.3. **Reliability of Treatment Mechanism**

The reliability of the treatment performance should be interpreted in the context of proper operation and maintenance, proper sizing relative to catchment characteristics, and any reasonably foreseeable operational limitations based on the physical, chemical or biological characteristics of the treatment device relative to the target land use. For instance, biological treatment processes may perform poorly in land use settings where high levels of herbicide use could be expected.

Other factors which may affect the reliability of the treatment mechanism include:

a. Steepness of slope at the installation site;

b. Groundwater table;

c. Geochemical characteristics of the catchment affecting runoff quality;

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1 The level of skill required to install the device could affect the performance of the device because if a higher level of skill is required, the risk of incorrect installation is higher or specialist training should be required.
13.4. Evaluation Report

An Evaluation Report will be written by an independent party and document outcomes against each of the factors in the evaluation matrix.

An evaluation report should provide an unambiguous statement of pass or fail against each of the matrix criteria and provide relevant commentary outlining how the decision was made.

Where a recommendation is made to reduce the performance claim and this is accepted by the claimant, rationale for recommending the claim should be provided along with the claimant’s acceptance of same and relevant summary of any correspondence or discussions in negotiating the outcome.

Similarly, where recommendations are made around performance reliability which may be impacted by physical, chemical or biological interplays between the treatment device the catchment land use and installation site conditions, this detail, any acceptance and dialogue should be captured in the report.

The report should provide definitive statement on the performance claim being accepted (or rejected), plus any limitations or qualifications. It should also recommend minimum information requirements that should be made available to prospective purchasers of the SQIDs in order they are able to make an informed determination on the suitability of the device for any given application.

Evaluation panel

The SQIDAC recommends that a panel of pre-qualified experts be established to provide an evaluation service for claims being made.

As a minimum members of the panel involved in assessment would need to have relevant technical expertise and be able to demonstrate independence.

Developing and maintaining a panel and requesting evaluations be undertaken would be involve administrative responsibility which currently doesn’t exist.

The SQIDAC seeks views on how independent evaluation of testing processes should be undertaken.

14. Field Evaluation and Quality Assurance Project Plan

This section details the requirements to conduct a LPT and is required to be followed when conducting a LPT.
14.1. Sampling and Analysis Protocol

Undertaking a LPT will likely require a significant investment of time and resources by the claimant. Proper sampling and analysis is critical to a LPT. Selecting the proper site, sampling representative rainfall events, equipment installation and maintenance, sample collection and flow monitoring, and ensuring the selected laboratories receive the samples and properly analyse and report them all play a part in obtaining good scientifically defensible data to serve as evidence for the purpose of the SQIDEP.

14.2. Role of the Performance Claim

The claimants Performance Claim forms the basis of the performance monitoring to be undertaken.

The Performance Claim shall be quantitative and definitive, stating the contaminant(s) the device is targeting and the predicted performance must be stated. The predicted performance must be supported by appropriate installation, operation and maintenance practices.

The claimant shall justify the method used to size the device for site specific applications as it is assumed that scaling would affect the performance claims at the different specific flow rates. The sizing recommendations must provide a defensible scaling relationship for the various performance claims and their corresponding specific flow rates if the device being tested is offered as a ‘family’ of devices, or the device comprises of modular components (e.g. variable sized sumps).

The scaling relationship can be developed in a laboratory. This is not required where scaling effects are demonstrated to be negligible and can be verified by well understood and accepted empirical techniques.

In some situations the use of computing techniques with and including a range of elemental analysis methodologies can be used to establish scalar relationship, particularly if these are able to establish in device conditions amenable to the treatment process being achieved (e.g. able to demonstrate steady, uniform or quiescent flow velocities and residence times conducive to treatment that relies on gravitational settling).

The claimant shall also provide the specific flow rates for which the performance claims are made (including maximums, minimums and circumstances the device operates in bypass mode). If a range of performance claims are made, the corresponding specific flow rates shall also be supplied.

The contaminants for which the device is being evaluated will determine appropriate sampling and analytical methods. Contaminants and appropriate methods are summarised in EPA guidance documents and should be acceptable for the relevant jurisdiction.

Selected analytical methods must be detailed in the approved QAPP.

For all tests that are to be considered as part of the evaluation, facilities undertaking the testing must be NATA accredited for the method (including reporting limits) at the time of analysis, and all tests must be completed within allowed holding times with appropriate sample preparation and preservation protocols in place.

Chain of custody documentation must be provided along with test results, and it is recommended that a minimum number (5%) of each samples batch are prepared for Quality
Assurance purposes and should include method and field blanks along with duplicate samples. Samples collected to provide field quality assurance should be in addition to any quality assurance processes undertaken by any testing facility.

**14.3. Quality Assurance Project Plan**

A Quality Assurance Project Plan (QAPP) is a document which shows how performance testing is to be conducted. Its objective is to ensure appropriate methods and procedures are followed and documented so that data obtained during testing is valid for verification of the device performance.

The QAPP must be prepared by the claimant and agreed by the independent evaluator before testing commences. The plan may be revised as necessary throughout the course of field testing with adjustments, notes and explanation provided.

The QAPP should contain background information on the device being tested, project organisation, sampling design and methods, laboratory methods, field and laboratory quality control, data management procedures, data review, and reporting.

The QAPP is developed for the purpose of planning the monitoring programme and to ensure that the proposed methodologies are executed in line with the contents of the QAPP, which are aligned with the protocols outlined in the SQIDEP.

The QAPP must be agreed by the claimant who should also commit adequate resources to implement the recommended testing. The QAPP shall be developed by a person with knowledge of the SQIDEP and a good understanding of field sampling and analytical chemistry methods. Where appropriate, it shall be developed in consultation with the analytical laboratories selected, especially if specialist analysis is required.

The QAPP shall be based on the claimant’s Performance Claim, and shall contain the details of:

- a. Data Quality Objectives.
- b. Organisational roles and responsibilities.
- c. Description of test site.
- d. Storm events sampled.
- e. Sampling equipment.
- f. Sampling methodology.
- g. Sampling location.
- h. Sampling Quality Assurance and Quality Control.
- i. Laboratory analysis.
- j. Laboratory Quality Assurance and Quality Control.
- k. Data management.
- l. Reporting.

The QAPP shall describe the procedures that will be used to ensure data quality and integrity. The QAPP shall detail how the following will be achieved in accordance with recognised publications which are equivalent to, or complement accepted EPA methods.
While the primary focus of the QAPP is to ensure collection of relevant, quality data for the purposes of evaluating performance claims, it is the responsibility of all parties involved to ensure that all activities are undertaken in a manner consistent with occupational health and safety considerations.

14.4. Description of Test Sites

Ideally, a test site shall be selected so the results can be applied elsewhere. The claimant shall propose a suitable site and demonstrate its appropriateness for performance testing to the evaluator.

This site shall be representative of the installation and land uses appropriate to the device and intended market segments. The test site land use shall be detailed (see Section 12.4 for categories of land use types).

It is considered good practice that the trial site water quality is examined to provide confidence that runoff quality will be appropriate to allow treatment efficacy to be demonstrated. Catchments delivering ‘clean’ water near or below irreducible concentrations or analytical method detection limits are unlikely to provide sufficient numbers of qualifying samples to allow definitive assessments to be undertaken.

Guidance on expected catchment characteristics should be sought from publications such as Australian Runoff Quality (ARQ) and expected pollutant concentrations should ideally lie within mean values reported for described land use types and within +/- 2 standard deviations (with lower limits being set by irreducible concentration or laboratory analytical considerations).

As part of demonstrating that a proposed trial site is appropriate, the claimant shall take samples to characterize the stormwater quality at the trial site, to ensure concentrations are greater than the laboratory Limit of Detection for the relevant contaminants. As an indication, stormwater should contain the average typical concentrations of contaminants as provided in 14-1.
### Table 14-1: Typical Untreated Stormwater Contaminant Concentrations Selecting SQID Trial sites

<table>
<thead>
<tr>
<th>Contaminants</th>
<th>Recommended Minimum Concentration*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids</td>
<td>Refer ARQ</td>
</tr>
<tr>
<td>Total Cadmium</td>
<td>Recommend actual concentration levels are shown in table (to be populated)</td>
</tr>
<tr>
<td>Dissolved Cadmium</td>
<td></td>
</tr>
<tr>
<td>Total Copper</td>
<td></td>
</tr>
<tr>
<td>Dissolved Copper</td>
<td></td>
</tr>
<tr>
<td>Total Chromium</td>
<td></td>
</tr>
<tr>
<td>Total Lead</td>
<td></td>
</tr>
<tr>
<td>Dissolved Lead</td>
<td></td>
</tr>
<tr>
<td>Total Zinc</td>
<td></td>
</tr>
<tr>
<td>Dissolved Zinc</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td></td>
</tr>
<tr>
<td>Dissolved Reactive Phosphorus</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td></td>
</tr>
<tr>
<td>Nitrate – Nitrogen</td>
<td></td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (TKN)</td>
<td></td>
</tr>
<tr>
<td>Total Petroleum Hydrocarbons (TPH)</td>
<td></td>
</tr>
</tbody>
</table>

*values are referenced from ARQ.

A full description of the test site shall be provided, and shall include the following:

a. Catchment area, land use, percentage impervious cover;

b. Aerial photos and site photos;

c. Geology, hydrogeology, soil types, surface hydraulics;

d. Potential pollutant sources;

e. Baseline stormwater quality;

f. Site map, showing catchment area, drainage system layout, treatment device, and sampling points, preferably GIS compatible;

g. Treatable flow rate;

h. Expected catchment flows;
Consultation Release

i. Make, model and capacity of treatment device;
j. Closest receiving water body;
k. Identification of bypass flow rates and/or flow splitter design;
l. Pre-treatment system, if any;
m. Site suitability – e.g. safety, access for flow measurements, power, phone; and
n. Any known adverse site conditions.

14.5. Data Quality Objectives

The Data Quality Objectives (DQO) are to obtain accurate and relevant data to assess the claimant Performance Claim. Data quality will be assessed against the criteria of representativeness, completeness, and comparability.

Where a device provides quantity control, it is essential that monitoring at a site considers both contaminant concentration and mass or load transported. Data collected must be representative of the entire storm event sampled, for each event that forms part of the device evaluation. Representativeness is largely achieved through the collection of flow-weighted event mean concentration samples, except for those contaminants that are obtained by grab samples.

The events sampled must also represent rainfall and thus runoff patterns for the catchment across an extended period of time and subject to the qualifying number of characteristic storms being achieved. Representativeness shall be assessed and reported.

Completeness of data will require that enough storm events are sampled to allow accurate evaluation.

The data collected must be able to be compared to performance at other locations. Comparability requires that the contaminants analysed (e.g. total suspended solids versus suspended solids concentration) and the sampling and analytical methods used can be compared.

14.6. Organisational Roles and Responsibilities

There are many different parties involved in measuring device performance. These generally include the regulatory body, claimant, general contractors (including installation and maintenance contractors), testing organisation, analytical laboratory, site owner, and the evaluation panel. All have roles and responsibilities in the successful completion of a project (USEPA, 2002).

Organisational roles and responsibilities shall be clearly identified in the QAPP. The claimant, sampling organisation (including both equipment and sampling), analytical laboratory, and reporting organisation shall be clearly identified, along with limits of their roles. Ideally, key personnel and their titles and contact information will be included. An organisational chart should clarify personnel and their roles (especially in confirming independence requirements).

14.7. Storm Events

The total number of storm events required for a statistically robust data set is noted in Section 11 as an area that SQIDAC seeks feedback.
At least three (3) of peak runoff flows from the sampled events should exceed 75% of the design flow rate of the device and one at or greater than its design flow rate. The sampling shall be carried out for each land use proposed by the claimant.

A minimum number of (qualifying) events is recommended is likely to achieve a satisfactory level of statistical significance between paired samples (influent Event Mean Concentration (EMC) and effluent EMC) of 90%. If the level of statistical significance is not able to be demonstrated more events must be sampled until the 90% statistical significance is achieved (or an altered claim can be considered commensurate with evidence).

Claimants may alternatively choose, with the approval of the evaluator, to conduct the field trials on multiple sites, with a statistically significant number of sampling events on each test site. A minimum of 90% statistical significance between influent and effluent treatment reductions must still be achieved. Ideally this would allow results collected across multiple sites to augment the knowledge base where it is demonstrated that key environmental parameters are within similar ranges.

In order to achieve a robust dataset across different climatic regions multiple testing sites may be required, however this will be in part dictated by how the treatment process is impacted by environmental variables, the characteristics of the pollutant being treated as well as the range of environmental factors (e.g. temperature, daylight hours).

Laboratory and field test configurations can be developed to accommodate hydraulic and pollutant throughputs based on catchment characteristics and hydrograph.

The SQID Advisory Committee seeks views on how variability in performance that could arise from variable environmental conditions needs to be accommodated, and appropriate statistical techniques that can be used to maximise the efficient interpretation of results across multiple test sites, and minimum numbers of qualifying events.

At a minimum it is likely that relevant key environmental parameters need to be monitored and reported in addition to test results where multiple sites used.

Qualifying storm criteria are defined for three features, the minimum storm depth, antecedent dry period and minimum runoff duration.

A minimum period of three days (72 hours) of no rainfall is recommended to differentiate between the end of one storm and the beginning of another. The 72 hour inter-storm event time is considered reasonable to balance catchment pollutant generation conditions and the practicalities of collecting and submitting samples for analysis.

Sampling events should be evenly distributed throughout the monitoring period to capture seasonal influences on storm conditions and device performance. Three (3) events should exceed 75% of the design water quality treatment flow rates of the design and one (1) event should exceed the design flow. This is the minimum number of suitable events to ensure that the performance of the device is sampled over its operating range.

The QAPP should allow results to be presented and interpreted along with qualifying storm characteristics as summarised in Table 10-1.
14.8. Sampling Equipment

Evaluation of device performance requires measurement of stormwater inflow into the device, outflow, stormwater quality, and rainfall.

Equipment is required to measure rainfall, inflow and outflow volumes, and some method of determining the bypass volumes must be incorporated (measurement or calculation). Equipment is also required to sample stormwater for laboratory analysis. For all equipment, the claimant and model of equipment, and procedures and schedule for calibration, inspection and cleaning shall be provided (USEPA 2002).

Consideration should be given to access for sampling equipment, equipment security and protection, and power (access to grid, or unobscured sky for solar) and phone supply (if the site is to be remotely telemetered, either land line access or cellular reception). The potential for power failure and subsequent loss of samples should also be considered (WSDE, 2004).

14.9. Automated Samplers

Automated samplers are to be used for all sampling, except where grab samples are required. The sampler shall be installed and calibrated according to the manufacturer’s instructions, and maintained between each sampling event. Information provided shall also describe how the sampler will be programmed, how sampling will be triggered, and how the sampler purges and rinses between samples (USEPA, 2002; WSDE, 2004). The bottle changing procedure shall be described. The suction tube material, length and vertical lift should be described, and the location of the tube inlet relative to flow conditions should also be described. Teflon shall be used for sampling organic constituents (WSDE, 2004).

14.10. Flow Monitoring

Flow monitoring equipment must be able to continuously monitor flow at regular intervals to match rainfall information (5 minutes or less is recommended) throughout the duration of a storm event and over the expected range of flows. Depth measurement or area/velocity devices are most common – selection will depend upon the test site and method of conveying stormwater (WSDE, 2004).

The flow at the inlet and outlet shall be measured. Monitoring of bypass flows is optional, however at a minimum the monitoring information should be sufficient to identify periods during which the device is operating in bypass mode. Proper presentation and interpretation of passing and bypassing flows is considered critical to ultimately supporting design outcomes.

Flow monitoring equipment shall be described (make and model), and the description shall include flow splitter and bypass flow set points, and flow conditions (gravity or pressure) (WSDE, 2004). Equipment must be installed and calibrated according to manufacturer’s instructions and as described in the QAPP.

As a minimum, the equipment’s internal desiccators, sensors and connections shall be inspected between each sampling event (USEPA, 2002). It is also recommended that in-pipe sensors and intakes be checked prior to each anticipated storm event targeted for sampling to ensure they are not blocked, damaged, or covered by sediments or gross pollutants.

When determining suitable flow monitoring configurations the relevant Australian Standards should be consulted and references provided.
14.10.1. **Accounting for internal bypass flows**

Some devices by nature of their internal geometry and treatment process may allow a portion of flows entering to be internally bypassed. In these instances flow monitoring should be sufficient to determine the treatment effectiveness across the devices (i.e. inlet and outlet conditions).

14.11. **Rainfall**

Rainfall shall be measured by a rain gauge that is capable of sampling at intervals of 5 minutes or less, and in increments no greater than 0.25mm. An electronic rain gauge connected to a data-logger is recommended. A non-recording rain gauge installed at the test site will allow the recording gauges totals to be calibrated and increase confidence in data.

The location of the rain gauge in relation to the test site shall be shown on a map. The rain gauge shall be installed and maintained according to manufacturer’s instructions, and as a minimum be checked and cleared of debris after each sampling event and calibrated at least two times during the testing period (if a non-recording gauge is used this can be emptied and ‘reset’ to achieve this). It is also recommended that rain gauges are checked prior to each anticipated storm event targeted for sampling to ensure they have not clogged and rainfall data is recorded during the monitoring event. Rain gauges shall be protected from excessive wind velocities that could skew accuracy of measurement.


14.12. **Scour**

For devices installed online, scouring might occur during large events. Any scouring effects shall be assessed and reported. The assessment may be in the form of hydrodynamic modelling. The claimant may alternatively propose a different methodology of assessing scour in consultation with the evaluator. Otherwise if the device is an offline device; and/ or there is sufficient evidence that scouring is not present, it shall be provided as part of the Performance Report.

In situations where there is the potential for scour to occur preventative strategies can be recommended as part of installation or maintenance methodologies.

14.13. **Sampling Methodology**

A flow weighted composite sample should be collected utilising an automated sampler whenever possible. However, some contaminants may require grab sampling depending on the preservation methods required under sampling protocols.

14.13.1. **Grab Sampling**

Grab stormwater samples are discrete samples (not composited), normally collected within the first 30 minutes after the onset of runoff, but no later than within the first 60 minutes. If grab sampling is required, the approach shall be clearly documented. The QAPP shall describe how the criteria for a qualifying storm event shall be met. The availability and preparedness of sampling staff shall also be demonstrated.

Grab sampling is required for constituents that transform rapidly, require special preservation, adhere to bottles, or where compositing can mask the presence of some contaminants through
dilution. Grab sampling is required for pH, temperature, total petroleum hydrocarbons (TPH), oil and grease, mercury (Hg), hexavalent chromium (Cr\(^{6+}\)), bacteria, cyanides, total phenols and residual chlorine. For all other constituents and pollutants, sampling shall be undertaken using automated samplers. Samples to be analysed for TPH shall be collected directly into the bottle that will be used in the laboratory. Samples for bacteriological analyses shall be collected into sterile bottles using appropriate clean sampling and equipment handling techniques in line with relevant EPA guidelines. Any deviation to these sampling requirements must be approved in the QAPP.

14.13.2. Automated Sampling

Where the constituent being measured does not require grab sampling, automated sampling can be undertaken. Samples can be taken by automatic flow-weighted compositing, or discrete samples that are composited later. Where samples are manually composited, it is recommended this is undertaken at the analytical laboratory to minimise risks of contamination.

14.13.3. Time-Proportional Sampling

Examples of good and poor hydrograph representation for time-proportional sampling are attached in the Appendices. This is a method of sampling that is best suited to auto sampling techniques.

A statistically representative number of discrete samples or sample aliquots shall contribute to each composite sample, with the emphasis on the hydrograph’s rising limb (Fassman, 2010), at both the inlet and outlet of the device.

The sampler should be programmed to take the maximum number of aliquots possible (USEPA, 2002). All samples collected from qualifying events should be analysed and reported.

While time-proportional sampling is acceptable, flow proportional compositing of the samples must be undertaken. The flow data will need to be readily available following a storm event to properly composite time-proportional samples and ensure holding times are met.

14.13.4. Flow-Proportional Sampling

As many aliquots as possible should contribute to the composite sample (Fassman, 2010; Ma et al, 2009) and should provide statistical confidence in representativeness.


Gross solids sampling must be undertaken in a manner consistent with operational and maintenance guidance.
The SQIDAC recognises the challenges associated with gross solids sampling, but considers that with the intent of developing a generic protocol which allows performance claims to be made and evaluated for all pollutant categories there needs to be compatible methods for assessing the claimed removal of gross solids.

At a minimum sampling techniques and frequencies should not artificially skew results as a consequence of altered operational activity during the testing phase.

The SQIDAC seeks views on how gross pollutant testing should be undertaken, and if specific guidance needs to be developed for this class of treatment device, and on what grounds.

### 14.15. Sample Location

The inlet sample shall be taken as close as possible to the device, at a minimum at a point where total site runoff is sampled. Likewise, effluent characterisation should account for total storm flow, including bypass if it occurs. For basic and enhanced treatments, gross pollutants (>500 µm) should be excluded (WSDE, 2004) from any captured water samples.

Outlet flow should be sampled either prior to or after mixing with bypass flow (Figures 14-1 and 14-3).

In either case, the contribution of bypass (if/when it occurs) shall be incorporated into the calculation of device efficiency (USEPA 2002) or design tools as appropriate as described below.

If the outlet flow is sampled prior to mixing with bypass flow (Figure 14-1) it should be noted when the bypass condition occurs (but it is not necessary to measure bypass flows). The performance claim must be made in relation to the device, and no removal can be claimed for the bypass flows. In this circumstance the performance claim claimed must be qualified as such; sizing and design advice must recognise this fact.

If the outlet and bypass flow is to be sampled together (Figure 14-2a), samples should be collected after sufficient mixing has occurred and prior to comingling with any other runoff. In this event bypass flows must be measured and the concentration of the bypass flows assumed to be the same as the device influent.

Figure 10-3 shows sampling and flow monitoring configurations for devices that allow internal bypass of entering flows. Often this may be due to changes in treatment veracity over the device’s design life (e.g. filters becoming clogged reducing hydraulic throughput).

If internal bypass occurs and samples are collected immediately after the treatment element (i.e. separate to internal bypass flows) additional flow monitoring will be required to allow the treatment effect for all flows entering the device to be calculated.
Figure 14-1. Flow Sensor and Sample Intake Locations (bypass flows not accounted for in analysis)

Figure 14-2a. Flow Sensor and Sample Intake Locations (bypass flows accounted for in analysis)
There is some potential for stormwater constituents to stratify during conveyance. To avoid sampling stratified flow, all sampling points shall be located where mixing of the flow is maximised (USEPA, 2002; WSDE, 2004). Sampling locations should be consistently located above and downstream of the tested device to allow representative consideration of stratification. It is recommended the location is agreed through the QAPP to accommodate operational realities of field testing.
Hydrocarbons or other light non-aqueous phase liquid which are likely to remain in a floating, free state at time of arrival at the testing site shall be sampled in accordance with recognised guidelines. Where emulsified hydrocarbons are expected justification should be provided and samples should be collected from a zone of representative mixing with appropriate collection and preservation techniques used.

Any variations to sample location must be approved in the QAPP.

14.15.1. **Sample Handling**

All field collected samples must be appropriately preserved and tested within required holding times in accordance with approved EPA guidelines relevant to the testing jurisdiction.

14.16. **Sampling Quality Assurance and Quality Control**

Operation and maintenance schedules for sampling equipment (e.g. automated), flow monitoring and rainfall equipment shall be provided.

Sample blanks for field and analytical testing will be supplied in accordance with QAPP and in line with recommendation in EPA guidelines.

Chain of custody documents identifying sample, collection agency, collection time, preservation used and laboratory receipt of sample and sample condition shall be provided.

14.17. **Laboratory Analysis**

All analysis shall be undertaken at laboratory or analytical facility with current NATA accreditation for requested analysis (including limit of reporting).

The method chosen for analysis shall be determined in the QAPP, including any justifications as considered necessary (e.g. depending on expected catchment conditions, analysis methods maybe chosen on the basis of limit of reporting).

14.18. **Reporting**

Reporting must be undertaken against the approved QAPP by an organisation independent of the claimant. The reporting organisation must have an understanding of the hydraulics and treatment mechanisms of the SQID, with knowledge and experience of proper sampling and flow measurement practices, and with the ability to properly interpret and report, without prejudice, the flow and water quality data. The organisation selected for reporting must be approved by the evaluator.

A statement verifying the independence of the report author and any agency involved in testing must be supplied.

A sample template for preparing a Performance report is provided as Appendix 2.

The SQID Advisory Committee seeks views on what should be included in a final Performance report.
14.19. Performance Reporting

The performance of a device needs to be reported consistently for efficient and accurate evaluation. This section discusses the requirements of the SQIDEP in terms of the framework of the report and the performance metrics.

14.20. Non-Detects

Non-detects are values reported to be at or below a reporting limit and/or detection limit. They need to be considered when analysing data as removing them may result in biased and non-representative estimated summary statistics of the monitored site (Helsel, 1988).

In the SQIDEP, non-detects are reported at the detection limit. If there are a large number of non-detects, the applicant can propose the use of a more reliable statistical method to analyse them, such as (1) regression on order statistics (ROS) method; (2) maximum likelihood estimation (MLE) method (Kayhanian, 2011).

14.21. Framework for Reporting

Performance reporting is required after the LPT is completed. Devices evaluated using the BoE route are also required to summarize existing data and report using the following framework.

The requirements for reporting are as follows:

a. Device information (extracted and summarised from AP Report);
b. Sizing methodology and its description, including any non-validated or non-referenced assumptions;
c. Sampling and analytical methodologies (extracted and summarised from QAPP);
d. Data reporting (for all qualifying events);
e. Discussion of any factors affecting the performance, including scaling effects and particle size distribution of both the influent and effluent. Other factors shall be included if deemed appropriate;
f. Box and Whiskers Plot for the Influent and Effluent Flows;
g. Statistical Significance Testing for EMC and/or Mass Loads; and
h. Analysis of Non Detects if applicable. Conclusions and Recommendation;
i. Data quality (below); and
j. Performance metrics (below), results and discussion.

14.22. Data Quality

The data collected shall be assessed and reported for the following factors:

a. Representativeness, completeness and applicability of rainfall/ runoff; and
b. Values relative to the detection limits of the analytical methods applied.

14.23. Performance Metrics

The pollutant removal capacity of a device needs to be consistent, and provided suitable information is collected at the time of field trials multiple metrics are able to be determined and
should point to a consistent interpretation for the highest levels of confidence in evaluating results.

The SQIDEP allows a number of performance metrics to be presented as follows:

a. Three (3) types of percent removal efficiencies;

b. Event Mean Concentration (EMC) and (if applicable) Mass Discharge Variability; and

c. Statistical significance of differences (if any) between inlet and outlet EMCs.

The details of each performance metric are outlined in Section 14.24 below.

14.23.1. Performance reliability and the statistical analysis of data

A qualifying of number of sampling events is required to verify the statistical representativeness of the removal efficiency. All performance metrics are supported by analysis of data collected when following this protocol, and all should provide a supporting case for the final accepted removal efficiency.

Performance reliability can be measured statistically by several methods. It is assumed that the removal efficiencies are unlikely to be normally distributed. The recommended statistical parameters for evaluating the performance reliability of the device are to:

a. Ensure that the 90% Confidence Interval of the arithmetic average is provided (CRE and/or MRE calculated as recommended). A Confidence Interval of greater than 90% is desired.

b. Measure the spread of the effluent data by analysing the distance of the lowest and upper most point from the 1st and 3rd quartile values (effluent EMCs) against the inter-quartile range (IQR). Within 1.5 times IQR is desired.

c. Calculate the arithmetic mean above and below the standard deviation (CRE and/or MRE). Within one standard deviation is desired.

d. Calculate the difference between the arithmetic average and the median (CRE and/or MRE). Within 10% is desired.

The ability to present test data in a variety of ways is considered a benefit of the way the field testing protocols have been constructed and will allow current and future performance targets to be considered by regulators and support a range of design approaches.

The SQID Advisory Committee consider that with appropriate data being collected, analysis for all metrics is a relatively straightforward process with modern computer tools.

Each metric relies on similar information being collected during the testing phase and each should provide a supporting case for verified performance claims.

The SQID Advisory Committee seek feedback into how multiple performance metrics should be presented and statistical testing undertaken, in particular determining a minimum number of qualifying events and appropriate confidence interval for acceptance of results.
14.24. **Removal and Performance Metrics**

The methods considered under the SQIDEP to compute and analyse removal rates and efficiencies are:

- Concentration Removal Efficiency (CRE);
- Mass Reduction Efficiency (MRE);
- Relative Achievable Efficiency (RAE);
- Summation of Loads;
- Removal Efficiency; and
- Flow Based Variability (FBV) Curve;
- Event Mean Concentration and Mass Discharge Variability

Analysis should clearly indicate how (treatment) bypass flows (either external or internal to the device) have been accounted for in the presentation of results.

14.24.1. **Concentration Removal Efficiency**

Pollutant Concentration Removal Efficiency (CRE) is computed to determine the reduction in pollutant concentration in a device. Calculations depend on the sampling equipment configuration, as per Figures 14.1-14.2. The formula for computing CRE is as follows:

\[
CRE(\%) = \frac{EMC_{in} - EMC_{out}}{EMC_{in}} \times 100
\]

Where:

- \( EMC_{in} \) is the event mean concentration measured in the inflow for each event; and
- \( EMC_{out} \) is the event mean concentration measured in the corresponding total outflow for each event.

If bypass occurs and is measured:

For Sampling Configuration shown in Figure 14.1, \( EMC_{out} \) is the event mean concentration measured in the treated effluent. Note, under this interpretation, if bypass is not measured, no credit can be reliably claimed for bypass and design guidance should allow bypass to be excluded from treatment.

If an alternative when bypass occurs and it is measured, \( EMC_{out} \) for the event is calculated as:
Equation 2:

\[ EMC_{\text{out}} = EMC_{\text{treated out}} \left( \frac{V_{\text{treated out}}}{V_{\text{total out flow}}} \right) + EMC_{\text{in}} \left( \frac{V_{\text{bypass}}}{V_{\text{total out flow}}} \right) \]

Where:

- \( EMC_{\text{treated out}} \) is the event mean concentration measured in the treated effluent for the event
- \( V_{\text{treated out}} \) is the measured flow volume treated by the device (not bypassing)
- \( V_{\text{bypass}} \) is the flow volume of the event that bypasses the treatment device (measured or calculated)
- \( V_{\text{total out flow}} \) is the flow volume downstream of the junction of the bypass and treated effluent, as per Figure 14-2a, b (measured and/or calculated).

To calculate and report the CRE:

1. Calculate CRE for each event, according to Equation 1.
2. Calculate the arithmetic average of the CRE over all events.
3. Calculate the 90% confidence interval for the arithmetic average of CRE.
4. Calculate the median CRE over all events.
5. Compute the difference between the arithmetic average CRE and the median CRE.
6. Calculate the arithmetic mean above and below the standard deviation for CRE.

Close agreement of median and average percent reductions indicate that the overall statistic is not influenced by an extreme event. If median and average values are greater than 10% different, the data set should be inspected for the presence of an extreme value(s) which may need further investigation or explanation.
14.24.2. **Mass Removal Efficiency**

Pollutant Mass Reduction Efficiency (MRE) is reported to determine the total mass of pollutant captured by the device. MRE calculations are relevant for devices which may provide runoff quantity management. The formula for computing MRE is as follows:

\[
MRE(\%) = \frac{V_{in} \times EMC_{in} - V_{out} \times EMC_{out}}{V_{in} \times EMC_{in}} \times 100
\]

Where:

- \(V_{in}\) is the flow volume of each event, measured at the inlet;
- \(V_{out}\) is the total outflow volume of each event, measured downstream of the junction of the bypass and treated effluent, as per Figure 14.2;
- \(EMC_{in}\) is the event mean concentration measured in the inflow for each event; and
- \(EMC_{out}\) is the event mean concentration measured in the total outflow for each event, as described by Equation 1 or Equation 2.

To calculate and report the MRE:

1. Calculate MRE for each event, according to Equation 3.
2. Calculate the arithmetic average of the MRE over all events.
3. Calculate the 90% confidence interval for the arithmetic average of MRE.
4. Calculate the median MRE over all events.
5. Compute the difference between the arithmetic average MRE and the median MRE.
6. Calculate the arithmetic mean above and below the standard deviation for MRE.

Close agreement of median and average percent reductions indicate that the overall statistic is not influenced by an extreme event. If median and average values are greater than 10% different, the data set should be inspected for the presence of an extreme value(s) which may need further investigation or explanation.
14.24.3. Relative Achievable Efficiency

The relative achievable efficiency (RAE) is computed to mitigate the influence of influent EMC on the percent removal calculations. The RAE is a function of benchmark or ‘irreducible’ concentration. This was derived from the ‘best’ median effluent concentration across all stormwater treatment devices reported in the International Stormwater BMP Database (Geosyntec and Wright Water Engineers, 2008). The RAE is calculated as follows:

Equation 4: RAE

$$RAE(\%) = \frac{EMC_{in} - EMC_{out}}{(EMC_{in} - C^*)} \times 100$$

Where:

- C* is an irreducible concentration used as a benchmark and taken from Table 14-3 (Fassman, 2010);
- V_{out} is the flow volume of each event, measured at the outlet;
- EMC_{in} is the event mean concentration measured in the inflow for each event; and
- EMC_{out} is the event mean concentration measured in the total outflow for each event, as described by Equation 1 or Equation 2.

To calculate and report the RAE:

1. Calculate RAE for each event, according to Equation 4.
2. Calculate the arithmetic average of the RAE over all events.
3. Calculate the 90% confidence interval for the arithmetic average of RAE.
4. Calculate the median RAE over all events.
5. Compute the difference between the arithmetic average RAE and the median RAE.

Table 14-2: Recommended C* Values Based on all Parameters in the 2008 International BMP Database Summary (Geosyntec and Wright Water Engineers, 2008)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>C*</th>
<th>Based on Treatment Device(s)</th>
<th>Number of Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Suspended Solids</td>
<td>7.6 mg/L</td>
<td>Media filter</td>
<td>33</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>N/A²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Water Quality Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration</th>
<th>Location</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Phosphorus</td>
<td>0.11 mg/L as P</td>
<td>Media filter</td>
<td>28</td>
</tr>
<tr>
<td>Dissolved Phosphorus</td>
<td>0.05 mg/L as P</td>
<td>Retention pond</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constructed wetland</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>0.65 mg/L as N</td>
<td>Biofilter</td>
<td>12</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen</td>
<td>0.77 mg/L as N</td>
<td>Biofilter</td>
<td>22</td>
</tr>
<tr>
<td>Total Nitrate</td>
<td>0.20 mg/L as N</td>
<td>Wetland basin</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>0.25 mg/L as N</td>
<td>Retention pond</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wetland channel</td>
<td>3</td>
</tr>
<tr>
<td>Total Nitrate + Nitrite</td>
<td>0.05 mg/L as N</td>
<td>Retention pond</td>
<td>22</td>
</tr>
<tr>
<td>Total Lead</td>
<td>1.20 µg/L as Pb</td>
<td>Wetland basin</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2.20 µg/L as Pb</td>
<td>Biofilter</td>
<td>50</td>
</tr>
<tr>
<td>Dissolved Lead</td>
<td>1.00 µg/L as Pb</td>
<td>Media Filter</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biofilter</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wetland basin</td>
<td>2</td>
</tr>
<tr>
<td>Total Zinc</td>
<td>19.00 µg/L as Zn</td>
<td>Retention pond</td>
<td>34</td>
</tr>
<tr>
<td>Dissolved Zinc</td>
<td>10.00 µg/L as Zn</td>
<td>Retention pond</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>19.20 µg/L as Zn</td>
<td>Biofilter</td>
<td>41</td>
</tr>
<tr>
<td>Total Copper</td>
<td>3.0 µg/L as Cu</td>
<td>Wetland basin</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5.0 µg/L as Cu</td>
<td>Media filter</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retention pond</td>
<td>27</td>
</tr>
<tr>
<td>Dissolved Copper</td>
<td>4.37 µg/L as Cu</td>
<td>Retention pond</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>5.90 µg/L as Cu</td>
<td>Biofilter</td>
<td>41</td>
</tr>
</tbody>
</table>

1. The recommendations are based on a rationale by Dr. E Fassman; the Geosyntec and Wright Water Engineers (2008) data summary does not provide recommendations for C*.

2. Only one device type indicated statistically significant differences between inlet and effluent, with median of effluent EMCs at 380 mg/L, and only 6 studies. Relatively fewer studies reported TDS in the BMP database.
14.24.4. **Summation of Loads**

The summation of loads method allows performance to be measured by calculating the ratio of all outlet loads to inlet loads.

\[
SOL = 1 - \frac{\text{Sum of inlet loads}}{\text{sum of outlet loads}}
\]

Or

\[
SOL = 1 - \sum_{i=1}^{n} \frac{C_{\text{inlet}} V_{\text{inlet}}}{C_{\text{outlet}} V_{\text{outlet}}}
\]

Where

- \(i\) duration of sample period
- \(n\) number of aliquots
- \(C_{\text{inlet}}, C_{\text{outlet}}\) inlet and outlet concentrations respectively
- \(V_{\text{inlet}}, V_{\text{outlet}}\) volumetric flow rate of inlet and outlet respectively

14.24.5. **Removal Efficiency**

The efficiency ratio is defined in terms of the average Event Mean Concentration of pollutants calculated over the duration of the analysed storm.

\[
RE = 1 - \frac{\text{average inlet EMC} - \text{average outlet EMC}}{\text{average inlet EMC}}
\]

\[
EMC = \frac{\sum_{i=1}^{n} V_{i} C_{i}}{\sum_{i=1}^{n} V_{i}}
\]

Where

- \(V_{i}\) Volume of flow during period \(i\)
- \(C_{i}\) Concentration associated with period \(i\)
- \(n\) Total number of aliquots collected during event
14.24.6. **Flow Based Variability (FBV) Curve**

The testing protocols call for each device to establish performance efficiencies, while tested over a range of flows. Any flow based variability is an effective way to establish a performance envelope for use in continuous simulating models, where flows passing through the device are constantly changing within a storm event.

A plot of removal efficiency vs proportion of nominal treatable flow should be prepared. This allows a calculable line of best fit algorithm to be produced, that can be reproduced within any sizing methodology calculation.

**Figure 14-4 – Example of FBV curve**

![Operating Efficiencies](image)

Other forms of the curve could be used that adjust for device scalability such as the volumetric loading rate (Lps/m³).

14.24.7. **Event Mean Concentration and Mass Discharge Variability**

The event mean concentration (EMC) and Mass Discharge variability are required to verify the ability of the device to manage large variability in EMCs and mass discharges.

Box and whisker plots should be prepared for influent and effluent EMCs as well as mass loads. The number of EMCs and mass loads contributing to each distribution should be clearly indicated.

The following explanation of a box and whisker plot is an excerpt from Geosyntec and Wright Water Engineers (2009):

“Box plots (or box and whisker plots) provide a schematic representation of the central tendency and spread of the data. A standard box plot consists of two boxes and two lines. The lower box expresses the range of data from the 25th percentile (1st quartile or Q1) to the median of the data
(50\textsuperscript{th} percentile, 2\textsuperscript{nd} quartile, Q2). An upper box represents the spread of the data from the median to the 75\textsuperscript{th} percentile (3\textsuperscript{rd} quartile or Q3). The total height of the two boxes is known as the interquartile range (Q3 – Q1). A “step” is 1.5 times the interquartile range. Two lines are drawn from the lower and upper bounds of the boxes to the minimum and maximum data points (respectively) within one step of the limits of the box. Asterisks or other point symbols are sometimes used to represent outlying data points. Some statistical packages, including standalone software and third-party spreadsheet extensions, also include the confidence interval about the median as notches in the boxes about the center line or can be customized to include specific data percentiles (e.g., 5\textsuperscript{th}, 10\textsuperscript{th}, 90\textsuperscript{th}, and 95\textsuperscript{th}).”

The above explanation is illustrated in Figure 14.5.

**Figure 14-5: Example Box and Whisker Plot with Explanation of Terms from Geosyntec and Wright Water Engineers (2009)**

* While the Y-axis label indicates total copper (TCu) expressed as ug/L, the procedure is equally applicable for TSS and many other water quality parameters.
14.25. Statistical Significance Testing

Statistical significance testing of differences between inflow and outflow Event Mean Concentrations and Mass Loads is required. This significance testing determines whether the difference is too large to have occurred by chance or too small such that it is insignificant.

The selection of the appropriate statistical significance test depends on the distribution and size of the data sets. For most water quality results, the distribution is usually log-normal, with the exception of some constituents such as pH (Pitt et al, 2005). Hence, statistical testing should be performed on transformed data, if appropriate.

The statistical significance testing on influent and effluent data sets should be tested with the following tests, as applicable:

1. Sign Test
2. Rank-Sign Test
3. Paired t-Test

Nonparametric tests (tests 1 & 2) are only needed if the data is not normally distributed (even after log transformation). If the data is normally distributed, only the paired t-test (test 3) applies. If the data is not normally distributed even after transformation, the paired t-test is not valid. The tests should be performed on the difference between the influent and effluent data sets.

14.25.1. Reporting Scour

The effects of scour shall be reported if the device is an online device. Alternatively, the claimant can provide evidence that the magnitude of scour is negligible in the device. The effects of scour shall be hydrodynamically modelled; otherwise an alternative option of demonstrating scour effects should be developed and reported in consultation with the Officer.

15. Certification

Ultimately it will be up to an agency or jurisdiction to choose to accept the performance claim that is substantiated at the end of a rigorous testing and evaluation regime.

Certification can occur at the level of an individual authority (e.g. a local council) or at varying regional and cross jurisdictional scales.

For the purposes of SQIDEP the mechanism or process for certification is not within scope, however certainty about the final outcome and how it will be administered in practice will be a key factor in making business decisions around undertaking rigorous testing regimes in accordance with the protocol.
Certification

While not in the technical scope of a testing and evaluation protocol the SQIDAC consider a resolution on how certifications or verification statements are going to be managed in practice.

This is an area where economy of scale makes sense, and additional effort in ensuring an extremely statistical robust testing regime may be justified if peak body recognition avoids the need to convince potential clients in multiple jurisdictions.

The SQIDAC seeks views on how a certification (or verification) scheme could be administered and how this is likely to be valued by industry. ADD words..

Examples or models that can be used.
16. References and further reading


California, Massachusetts, Maryland, New Jersey, Pennsylvania, Illinois and Virginia. Available Online: [http://www.state.nj.us/dep/dsr/bscit/Documents.htm](http://www.state.nj.us/dep/dsr/bscit/Documents.htm)


## Appendix A

### QAPP Checklist

<table>
<thead>
<tr>
<th>Item</th>
<th>Included</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Quality Objectives.</td>
<td>Y/ N</td>
<td>Describe Data Quality Objectives</td>
</tr>
<tr>
<td>Organisational roles and responsibilities</td>
<td>Y/ N</td>
<td>Describe roles and responsibilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Statement of independence provided.</td>
</tr>
<tr>
<td>Description of test site</td>
<td>Y/ N</td>
<td>Maps or drawings provided</td>
</tr>
<tr>
<td>Storm events sampled</td>
<td>Y/ N</td>
<td>Confirmation of qualifying event criteria</td>
</tr>
<tr>
<td>Sampling equipment</td>
<td>Y/ N</td>
<td>Description of equipment, calibration and installation requirements met</td>
</tr>
<tr>
<td>Sampling methodology</td>
<td>Y/ N</td>
<td>Method statements provided</td>
</tr>
<tr>
<td>Sampling location</td>
<td>Y/ N</td>
<td>Diagrams and confirmation of field placements</td>
</tr>
<tr>
<td>Sampling Quality Assurance and Quality Control</td>
<td>Y/ N</td>
<td>Sampling Quality Assurance and Quality Control plan provided</td>
</tr>
<tr>
<td>Laboratory analysis</td>
<td>Y/ N</td>
<td>Relevant laboratory analysis and methods provided</td>
</tr>
<tr>
<td>Laboratory Quality Assurance and Quality Control</td>
<td>Y/ N</td>
<td>Laboratory Quality Assurance and Quality Control plan provided</td>
</tr>
<tr>
<td>Data management</td>
<td>Y/ N</td>
<td>Protocols for data management provided</td>
</tr>
<tr>
<td>Reporting</td>
<td>Y/ N</td>
<td>Reporting framework provided</td>
</tr>
<tr>
<td>Statement of acceptance</td>
<td>Y/ N</td>
<td>Statement of acceptance of QAPP by independent reviewer provided</td>
</tr>
<tr>
<td>Qualifications of independent reviewer</td>
<td>Y/ N</td>
<td>Qualifications of independent reviewer provided</td>
</tr>
</tbody>
</table>
Appendix B

Draft report Template

Suggested Report headings

1. Name and contact details of device manufacturer and/or claimant (as appropriate);
2. Name and contact details of independent testing agency;
3. Description of Specific quantitative Performance Claim;
4. Literature review of relevant research;
5. Description of device, treatment process(es);
6. Description of device, operational considerations;
7. Description of testing site and relevance to performance claims;
8. Quality Assurance Project Plan and description of testing and conformance against each heading;
9. Description and confirmation of maintenance regime(s) during testing;
10. Discussion of results against adopted performance metrics including statistical analysis;
11. Results conclusions;
12. Qualifications or limitations of results;
13. Supporting documentation including maintenance, sizing and installation aspects;
14. Statements of independence of testing agencies;
15. Confirmation of independence of testing provided by claimant;
16. References,
Appendix 3

Graphical Examples of Good and Poor Hydrograph Representation
Field sampling using automated equipment can present numerous challenges. It is highly likely that at least as many storms will pass un-sampled or poorly sampled, as they will successfully sampled, due simply to the highly variable nature of storm events. Frustration is inevitable. A series of “missed” storms can easily tempt field operators to analyse whatever samples are collected, regardless of hydrograph representation. Diligence and ‘getting to know’ the field site from a hydrologic standpoint are key elements of a successful field sampling programme. Time should be allowed for hydrologic monitoring prior to initiating a water quality sampling regime. This will efficiently set / re-set the samplers to capture representative samples over the hydration of the hydrograph (Fassman and Shamseldin, 2009).

The following figures illustrate examples of representative hydrograph sampling and non-representative hydrograph sampling. For the purpose of the SQIDEP a representative flow weighted composite sample should be collected unless limitations do not allow. Sampling must occur in a manner that will allow a defensible Event Mean Concentration (EMC) to be produced for each storm event.

Properly conducted pollutograph and time weighted sampling can produce a defensible EMC. Thus, examples of pollutograph sampling and time weighted sampling are also presented.

Figure A1 presents a representative flow weighted composite sample. The rising limb, peak, and falling limb of the hydrograph are sampled in a representative flow weighted manner. This hydrograph is taken from a river system. It is important to note that a hydrograph on a small subcatchment, where a proprietary device is likely to be trialed, will likely not rise and fall this evenly. It will likely be composed of several peaks since it will be subject to sudden episodic flows directly related to site rainfall. This hydrograph is presented to illustrate flow weighted composite sampling.

In the pollutograph samples illustrated in Figure A_2, the peak flows have been captured and samples are representative of the entire storm event. The samples from a pollutograph may be analysed separately, and a linear relationship between samples developed to produce an EMC. This method not only provided an EMC, but also produces data on the performance of a proprietary device at various flows. Care must be taken to represent the entire storm event, and not just the rising limb or peak flows.

A composite sample may be mixed from time weighted sampling following collection. However, the representation in Figure A_3 was collected on a time weighted basis. The peak flows, with the exception of the first sample, were missed. Thus, any composite sample produces would not be representative of the storm event. This storm would not be admissible for an evaluation in the SQIDEP process.

Figure A3 also illustrates another disadvantage of time weighted sampling. Since the flow weighted composite sample would be mixed from the time weighted samples proportional to the flow, the first sample would comprise a majority of the flow weighted composite sample and the remaining six samples would contribute very little volume to the total amount. Thus, the total amount of sample available to analyse would be very limited and may not allow for analysis of all analytes that are being analysed for.
Figure A4 presents an example of a representative time weighted hydrograph. The majority of the hydrograph is represented. Samples were collected closer together at the front of the hydrograph and further apart as the storm event progressed. A flow weighted composite sample should be producible from this hydrograph. However, this does require the additional step of analyzing the flow data and compositing the sample. Samples can be analyzed separately and a linear relationship developed between samples to produce an EMC similar to a pollutograph sample.

Figure A-1 Example of a Representative Flow Weighted Composite Hydrograph Capturing Peak Flow
Figure A-2 Examples of Representative Pollutograph Sampling Hydrographs Capturing the Peak Flows

(a)

(b)

© Stormwater Australia
Figure A.3 Example of Non-representative Time Weighted Sampling Hydrograph Missing the Peak Flows

Figure A.4 Example of Representative Time Weighted Sampling Hydrograph Capturing Peak Flows