Evaluation Protocol (SQIDEP) for Stormwater Quality Treatment Devices

JANUARY 2015
CONSULTATION RELEASE
Technical Summary

Stormwater Quality Improvement Devices Evaluation Protocol (SQIDEP)

This paper has been prepared to assist Stormwater Australia's industry consultation on developing a nationally consistent approach to evaluating the performance of Stormwater Quality Improvement Devices (SQIDs).

It outlines the relevant technical considerations that have been recommended or upon which the Stormwater Quality Improvement Device Advisory Committee (SQIDAC) seek further input from industry and academia.

This summary document sits as a companion to a summary document requesting industry feedback on the procedural requirements to administer assessment of performance claims against any agreed methodology.

An overarching document has been developed by Stormwater Australia which provides greater detail on both technical and procedural considerations and has been based on work completed by the Auckland Council.

Stormwater Australia would like to acknowledge the importance of this piece of work and the efforts of authors and contributors toward developing a framework for issues to be considered.

How to use this document

This document has been developed to provide a high level summary of the more comprehensive SQIDEP consultation draft.

It outlines the various sections of the complete document and highlights the various technical issues on which the SQIDAC seeks views. The document has been structured to allow reference back to the complete document. As much as possible we have attempted to raise these issues as questions with some supporting context where possible.

Feedback is requested through the forums specifically set up for the purpose on the Stormwater Australia website or via email at feed.

To support discussion and transparency of views feedback, is being sought through an open forum. Stormwater Australia reserves the right to moderate content it deems as inappropriate or offensive (e.g. derogatory remarks, posts critical of specific claims which name individuals or products)

SQIDEP Discussion paper

The complete SQIDEP discussion paper sets out a detailed glossary of terms and outlines some of the background behind Stormwater Australia's desire to establish a nationally consistent approach to evaluating protocols, and seeks feedback in areas relating to technical and process issues, and are summarised below.

In this document the light gold breakout boxes in the SQIDEP discussion paper are provided (along with a page reference from the master document) along with a summary context. If you wish to understand the issue in the full context of the discussion paper you can refer to relevant section by referencing the page number.

Light gold breakout boxes are used throughout the SQIDEP consultation documents to identify areas where the SQID Advisory Committee seek technical feedback and further input.

Light blue breakout boxes are used throughout the SQIDEP consultation documents 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.

Technical Protocol Development	SQIDEP provides clarity on key information requirements for performance claims to be assessed, including- • Independence of testing agency; • Quality Assurance requirements for collection of evidence; • Acceptance will provide clarity for organisations currently undertaking or planning field test or supplying to industry.	SQIDAC seeks further input on specific areas: • The role of historical information (e.g BoE route) and how this is best able to be used effectively; • Level of confidence placed in transposing laboratory results to field conditions; • Standardising definitions (in particular TSS); • Specific field conditions for qualifying storm events and sample collection; • The role of multiple performance metrics in increasing confidence; • Potential to consider data from different testing sites to improve levels of confidence in performance; • Specific techniques to account for gross solids/ pollutant sampling and presentation of results; • Structure of and information included in final performance report.
Supporting administrative arrangements	Separate to the development of technical protocols there needs to be supportive administrative arrangements that offer confidence in outcome, potential efficiencies in evaluation and supported by a business and financial model that supports scheme longevity.	SQIDAC seeks further input on specific areas: • How performance outcomes can be perpetuated through operation and maintenance cycles; • How industry could administer evaluation of claims assessment against agreed protocols; • Qualifications of persons undertaking evaluation; • The potential role of any certification of claims arising from evaluation; • Potential efficiencies in undertaking assessments and how this may be of benefit; • Mechanisms for dealing with unsubstantiated claims; • Expectations around assessment timeframes;

SQIDEP consultation areas

Section 6. Making Performance Claims (p15)

It is an important distinction that the technical protocol does not prescribe a target pollutant or performance level. Instead the focus has been to describe a process which remains 'outcome neutral' in that it is up to the claimant to nominate the performance claim and then provide evidence to substantiate this at the desired level of statistical confidence.

The claim should include details of upper performance levels and performance envelopes (e.g. flow conditions).

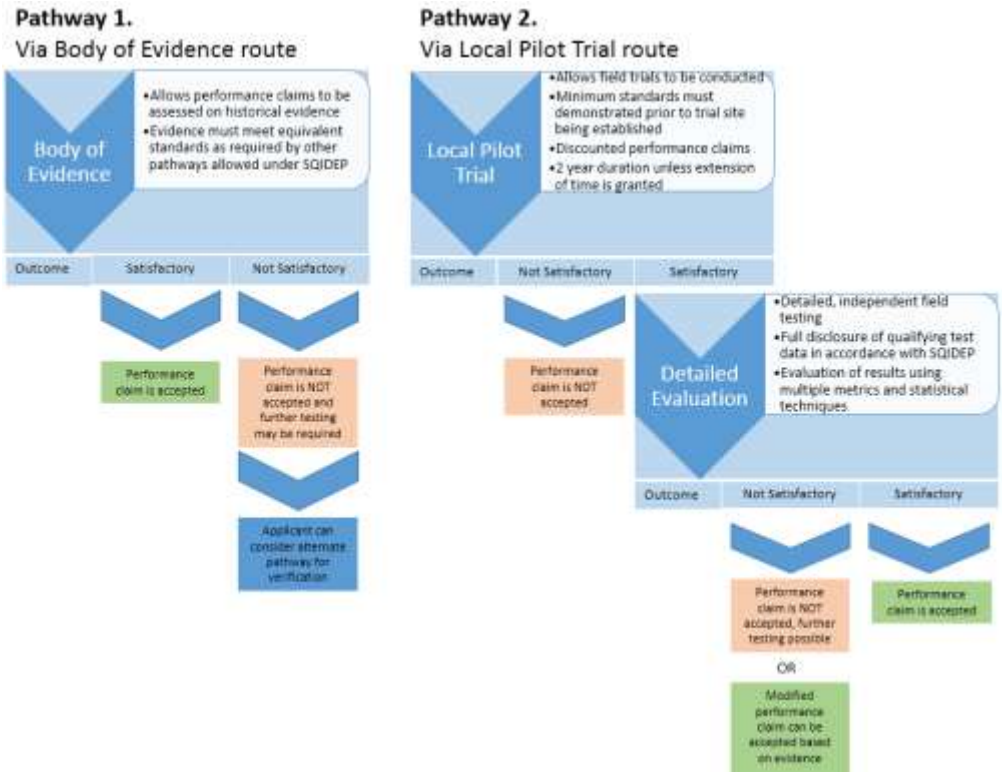
If evidence does not support the claim a reduced level of performance may be acceptable, the claim may be rejected outright or the claimant may opt to undertake supplementary testing with the aim of increasing confidence levels and have the claim re-assessed.

There are a number of components built into the protocol which are designed to support the approach to assessing claims and include:

- Defining a minimum number of events and flow conditions (esp. for field testing) for which results need to be demonstrated;
- A requirement to report all qualifying data;
- Including a requirement to analyse results using a number of techniques (including at least one non parametric, statistical method) and interpreting these for a consistent outcome.

Section 7. Limitations of the Protocol and pathways (p 16)

This section clarifies the intent of the protocol is for permanent installations which address quality/ pollution and presents a two pathways to allow testing and evaluation to occur.



Sections 8 and 9. Making applications against this protocol (p 20)

An application report should be provided for assessment purposes and include the following information (note the full document provides further explanation for these):

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.

c. The Performance Claim must be supported by data obtained using scientifically robust test procedures and analytical techniques.

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.

f. Physical description of the device, including engineering drawings showing key dimensions which determine hydraulic and treatment performance, and installation and maintenance parameters.

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.

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.

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.

m. Recommendations on design sizing, operation and maintenance requirements.

n. Operation and maintenance information relevant to the ability to ensure proper functioning of the device.

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).

The protocol describes two pathways for claims to be made. Note that this distinction has been made primarily to recognise that some devices may have undergone historic testing or testing in other jurisdictions and a pathway to have this information considered is provided. In all instances the same requirements for quality information sufficient to demonstrate statistical confidence is required.

Section 10. Body of Evidence (p 23)

A body of evidence pathway is provided for devices which have historic data that may be relevant to the evaluation process.

(p 24)

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.

The protocol recommends presenting influent and effluent concentrations on both a mass and concentration basis and matching these to gain a fair comparison of before and after water quality. Recognising that there has been significant work in the past to characterise devices which treat Total Suspended Solids feedback is sought on appropriate definitions for this class of pollutant.

(p 25)

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.

Where further testing is required (i.e. Pathway 2) the process requires that sufficient justifying evidence is provided to support field trials. The exact nature of the justifying evidence will depend on the nature of the claim, however it is likely this will include laboratory prototype testing.

For both evaluation pathways a detailed evaluation is undertaken during in which all information provided is considered using a performance evaluation matrix using pass/ fail criteria.

A pass in all matrix areas is required for the claim to be substantiated (see Section 13).

Section 11. Minimal technical information requirements under the SQIDEP

The following table sets out minimum information requirements under the SQIDEP and outlines the type, number and representatives of the storm events that need to be considered for both field and laboratory evaluation. Note that the laboratory evaluation route is a precursor to undertaking more detailed field evaluations which are the ultimate requirements for the highest level of confidence in the performance of treatments under real world conditions.

The table also outlines proposed requirements for sample collection, measurement and calibration of measuring equipment and tools and techniques for interpreting results and understanding any variability in performance.

Specific questions are raised in relation to a number of these, and feedback is sought.

Table 11-1 Minimum data and qualifying event requirements for assessment

Requirements	Field Evidence Criteria	Full Scale Laboratory Evidence Criteria
Sampling Events		
Type of Event	Rainfall Events[1]	Test Runs[2] [3]
Minimum Number of Events	Statistically relevant. Minimum of 10- 15 (to be confirmed)	15 (minimum 3 at each flow rate)
Minimum Rainfall Depth	Total event rainfall depth ≥2mm	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
Minimum/ Maximum Storm Duration/ Volume	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.	
Minimum Inter-event Time	72 hours. * (see discussion points following)	
Device Size	Full Scale	Full Scale
Runoff Characteristics	Target pollutant profile of influent and effluent	(for TSS) Particle size distribution of influent and effluent otherwise Target pollutant profile of influent and effluent
Runoff Volume or Peak Flow	Runoff at least 3 events should exceed 75% of the design water quality volume/ treatment flow rates of the design & 1 event greater than the design flow	See rainfall depth comments above
Sampling Procedures and Techniques		
Automated Sampling	Composite samples on a flow weighted basis	
Minimum Number of Aliquots	8 per event* (see discussion points following)	
Hydrograph coverage	Indicative 50% (importantly the rising and falling hydrograph components should be included in testing, and dependent on catchment and rainfall patterns, multiple peaks should be accounted for).	Information outlining criteria for establishing laboratory testing and relationship with real world storm events
Manual Sampling	Only for constituents that transforms rapidly, require special preservation or adhere to bottles, or where compositing can mask the presence of some contaminants through dilution. See Section 10 for details.	
Sampling Location	As identified and agreed in the submitted QAPP	
Analytical Methods	Various (refer to agreed EPA reference document) and/or Standard Methods (for organic, inorganic and biological analysis as required)	
Chemical and Physical analytes	As identified and agreed in the submitted QAPP	
Requirements	**Field Evidence Criteria**	**Full Scale Laboratory Evidence Criteria**
Flow Measurement Location	Inlet, Outlet and Bypass*, as applicable. Based on relevant accepted measurement protocols for flow type (e.g. open channel, in pipe)	
Precipitation Measurement	Automatic rain gauge	N/A
Recording Intervals	5 minutes or less	
Recording Increments	No greater than 0.25mm	
Rain Gauge Calibration	Twice during verification period	

[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		
Performance Indicators	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	

(p 28)

The SQIDAC seeks Commentary/ feedback on the following aspect of Table 11-1.

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.

Section 12. Local Pilot trials (field testing)

Local pilot trials allow for an initial evaluation to determine if there are sufficient prospects of success to justify a device being installed for field testing.

If the evidence supports a Local Pilot trial being undertaken a quality assurance project plan should be developed in consultation with an independent testing agency which will oversee the entire process.

Along with Body of Evidence evaluation, laboratory testing is considered an important step in determining confidence to undertake a LPT.

This 'initial claim' should be supported by evidence in any of the following categories:

- Theoretical supporting evidence of the device's performance; and/or
- Laboratory studies or controlled field tests demonstrating the device's performance; and/or
- 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.

It will be a necessary part of the process in establishing LPTs that some level of claim will need to be made, but that until verified there shouldn't be a blanket, perpetual acknowledgement of the claim.

(p 30)

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.

Local Pilot Trials should be supported by a sound rationale for site selection and included in the methodology. In summary

- Site Characteristics and relevance of site to target pollutants to be treated. Australian Runoff Quality is provided as a reference to guide the selection of appropriate test sites for different land use and pollutant profiles. In general different land uses are described (e.g. residential, commercial) and the pollutant potential for each category needs to be considered to ensure meaningful test results can be attained[1]. A number of references

[1] Field tests undertaken in 'clean' catchments are unlikely to produce meaningful results. Inappropriately sized (e.g. undersized) treatments in 'dirty' catchments may result in poor performance or excessive maintenance regimes. Matching a treatment to a catchment based on expected runoff characteristics is an important aspect of undertaking a relevant field testing process.

are provided which describe methods and techniques which should be considered when designing and undertaking field trials.

- A Quality Assurance Project Plan needs to be produced prior to any field trial being implemented. The minimum requirements of the QAPP are discussed later in this summary document.
- The period in which a Local Pilot Trial can be conducted is limited to two years however extensions of time can be granted for legitimate reasons which can include climatic limitations (insufficient number of qualifying storm events), or minor modifications to the device based on improved operational knowledge.

At the conclusion of any field trials a Detailed Evaluation of the results should be undertaken by an appropriately qualified and independent assessor.

A report needs to be prepared covering key areas outlined in a performance matrix (used for pass/ fail evaluation in all facets) and includes:

Section 13. Detailed Evaluation Phase

The detailed evaluation phase allows for evidence collected through any validation pathway to be considered through the lens of a performance matrix. A Pass outcome is required in all criteria for an evaluation to report the claim is substantiated, and there is scope to allow a reduced or qualified evaluation outcome.

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

Constructability	Pass/ Fail	Relevant information for installation is provided
Operation and Maintenance	Pass/ Fail	Operation and maintenance manuals are provided and consistent with testing procedures.
Reliability of treatment mechanism	Pass/ Fail**	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.

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

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

Section 14 Field Evaluation and Quality Assurance Project Plan

This section discusses the specific requirements for undertaking a testing program, and includes quality assurance consideration through a Quality Assurance Project Plan (QAPP).

For any field trial a QAPP must be developed and agreed with an independent party that will be responsible for conducting trials. The QAPP covers the following aspects:

- Sample and analysis protocols;
- Articulating the performance claim;
- Data Quality Objectives;
- Organisational roles and responsibilities;
- Description of test site;
- Storm events sampled;
- Sampling equipment;
- Sampling methodology;
- Sampling location;
- Sampling Quality Assurance and Quality Control;
- Laboratory analysis;
- Laboratory Quality Assurance and Quality Control;
- Data management; and
- Reporting.

The SQIDEP describes each of these aspects and sets out minimum expectations as required (e.g. sample collection and analysis should be supported by Chain of Custody documentation and include field duplicates to increase confidence in methodology and results).

Importantly the QAPP recognises that there will be variability in results at a particular site and across sites (if multiple test sites are used), and the requirement to present full disclosure of results from qualifying storms is paramount.

Where datasets for particular treatments (or potentially classes of treatment) exist across multiple sites there is interest in gathering views on whether these can be combined to provide a more extensive (and perhaps more statistically robust) dataset.

(p 46)

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.

Extensive discussion on sampling procedures is provided, including the roles of grab, automated and composite samples and some of the practical limitations of different sampling equipment.

Procedures for measuring flow are also discussed, with a focus on being able to ‘flow match’ influent and effluent samples and adequately account for bypass (device bypass or internal bypass).

Specific questions are raised about gross solids sampling (which have the potential to skew results if they proportionally represent a significant mass or volumetric load).

(p 48)

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.

The location of the sample collection point relative to flows through and around the device are also described with implications for analysis of results.

Reporting

Reporting requirements (i.e. discussion and analysis of test results and any conclusions reached) are provided.

The recommended framework for reporting follow the QAPP closely and includes the following:

- Device information (extracted and summarised from AP Report);
- Sizing methodology and its description, including any non-validated or non-referenced assumptions;
- Sampling and analytical methodologies (extracted and summarised from QAPP);
- Data reporting (for all qualifying events);
- 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;
- Box and Whiskers Plot for the Influent and Effluent Flows;

• Statistical Significance Testing for EMC and/or Mass Loads; and

- Analysis of Non Detects if applicable. Conclusions and Recommendation;
- Data quality (below); and
- Performance metrics (below), results and discussion.

(p 51)

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

The performance metrics recommended for use by the SQIDEP are:

- Concentration Removal Efficiency (CRE);
- Mass Reduction Efficiency (MRE);
- Relative Achievable Efficiency (RAE);
- Summation of Loads;
- Removal Efficiency; and
- Flow Based Variability (FBV) Curve.
- A number of performance metrics are described for use with a requirement that more than one be used along with statistical (non-parametric) analysis to support considered conclusions based on consistency of interpretation and established statistical methods.

With consistency in collecting and reporting data it is hoped that overtime a growing confidence in data across all tested sites may be realised.

(p 53)

The ability to present test data is 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 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.